PHILIPS

SIGNAL GENERATOR

PM 5321

RIVERSDALE TECHNICAL COLLE

9499 520 03411

1/1170/3

MP MASTER

MA24512

PHILIPS

Manual

SIGNAL GENERATOR

PM 5321

RIVERSDALE TECHNICAL COLLEGE

9499 520 03411 1/1170/3

IMPORTANT!

In correspondence concerning this apparatus please quote the type number and serial number as given on the plate at the rear of the apparatus.

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GENERAL PART

Introduction

The PM 5321 signal generator has in the first place been designed for checking and adjusting of A.M., F.M. and TV receivers in service workshops. Thanks to its versatility the apparatus is also very suitable for use in laboratories and at technical schools. The frequency range comprises the A.M./F.M. broadcast bands and A.M./F.M./TV intermediate frequency ranges. The output voltage can be modulated in amplitude over the entire frequency range. In the F.M. band and A.M./F.M. intermediate frequency ranges frequency modulation is also possible.
On account of the fact that the apparatus is also suitable for frequency modulation in the I.F. ranges it lends itself very well for the visualisation of band-pass curves of I.F. amplifiers and I.F. filters on the screen of an oscilloscope. As a result, a receiver can be adjusted much faster than when use is made of the time-consuming system of measuring the response curve point by point.

The following adjustments and measurements can, for instance, be carried out:

- adjustment of R.F. and I.F. circuits and stages;
- gain measurements on receivers;
- sensitivity measurement on A.M. and F.M. receivers;
- adjustment of discriminators;
- measuring the A.M. suppression of ratio detectors or other F.M. detectors.

Short description of the apparatus

II

The generator contains a balanced oscillator with a double triode as oscillator valve. The total frequency range is divided into eight ranges, continuous tuning being effected by means of a double, variable capacitor. An adjustable series resistor in the anode circuit of the oscillator valve makes it possible to keep the output voltage constant for each frequency.

The oscillator is frequency modulated by means of a diode connected in parallel across one half of the tuned circuit of the oscillator. This diode works as a variable capacitance and affects the tuning of the oscillator in conformity with the voltage applied.
Amplitude modulation is effected on the suppressor grid of the tube which separates the oscillator circuit from the output circuit.
The oscillator voltage is rectified by means of a germanium diode and fed to the output meter. The amplitude is adjusted to the correct value by means of a continuously adjustable attenuator with constant impedance and logarithmic characteristic.
The 1000 c/s modulation signal required for A.M. and F.M. is generated by a single-stage RC oscillator (phase-shift oscillator). This signal is available on socket "1 kHz". The modulation signal of 50 c/s is derived from the mains. The latter voltage is available on socket "FM" and is adjustable in phase.

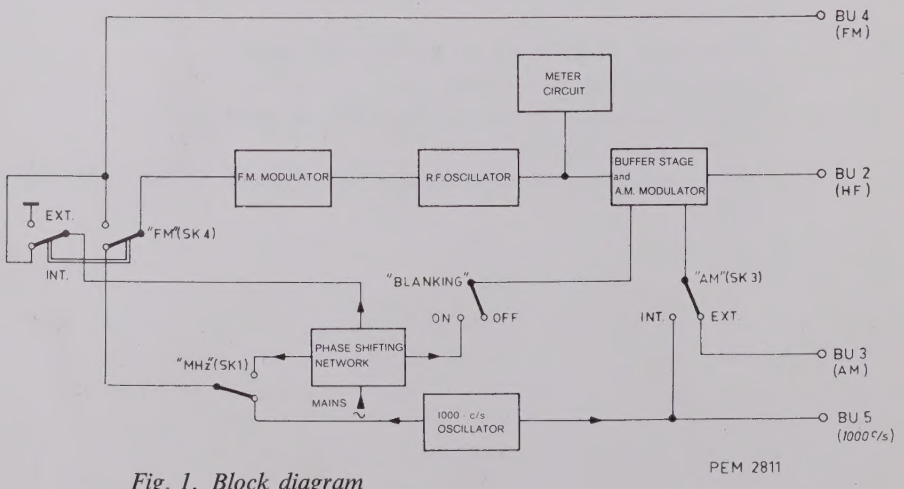


Fig. 1. Block diagram

Technical data

III

Properties expressed in numerical values and in which tolerances are stated are guaranteed. The other numerical values indicate the properties of the average apparatus and serve only for guidance.

Frequency ranges	0.15 – 0.48 Mc/s	15 – 50 Mc/s
	0.48 – 1.5 Mc/s	10 – 11.5 Mc/s
	1.5 – 4.8 Mc/s	88 – 108 Mc/s
	4.8 – 15 Mc/s	0.4 – 0.5 Mc/s
Frequency error	$\leq 1\ \%$	
Output voltage (at a load of 75 Ω)	maximum 50 mV, adjustable for all ranges.	
Output attenuator	continuously logarithmic up to approximately 80 dB.	
Output impedance	75 Ω (BNC-connector)	

MODULATION:

Amplitude modulation

internal:

in all ranges

modulating frequency	: 1,000 c/s
modulation depth	: 30 %
L.F. output voltage	: 4 $V_{r.m.s.}$

external:

in all ranges

modulating frequency	: 20 c/s...20 kc/s
modulation depth	: 0...75 %
required L.F. voltage	: approximately 5 $V_{r.m.s.}$ for 30 % modulation

Frequency modulation:

internal

in the ranges	0.4–0.5 Mc/s	10–11.5 Mc/s	87.5–108 Mc/s
modulating frequency	mains freq.	mains freq.	1,000 c/s
frequency sweep (2Δ f)	20 kc/s	400 kc/s	150 kc/s
L.F. output voltage	10 $V_{r.m.s.}$ (adjustable phase)	10 $V_{r.m.s.}$ (adjustable phase)	4 $V_{r.m.s.}$

external	
Ranges	As with internal modulation
Modulating frequency	0...5 kc/s
Required voltage	15 $V_{r.m.s.}$ for maximum sweep
Blanking	Can be switched on only for internal frequency modulation, mains voltage.
Supply:	The apparatus can be adapted to mains voltages of 110, 125, 145, 200, 220 and 245 V 40–60 c/s 40 Watts
Dimensions:	height 29 cm; width 22 cm; depth 28 cm
Weight:	9 kg

Accessories

IV

Mains flex

Manual

Plastic cover

Measuring cable

To be ordered separately:

Dummy aerial (4822 210 70023)

Impedance transformer (PM 9532 B)

DIRECTIONS FOR USE

For the positions and functions of knobs and sockets, see Fig. 3.

Installation

A. ADJUSTING TO THE LOCAL MAINS VOLTAGE

The apparatus is provided with a mains voltage adapter, which can be set to mains voltages of 110, 125, 145, 200, 220 and 245 V. The voltage value adjusted can be read through the round opening (A, Fig. 2) at the rear of the apparatus.

Adjustment to another mains voltage is effected as follows:

- Remove the rear panel of the apparatus.
- Pull the adapter out, turn it until the correct mains voltage is uppermost and press the adapter back again.
- Refit the rear panel.

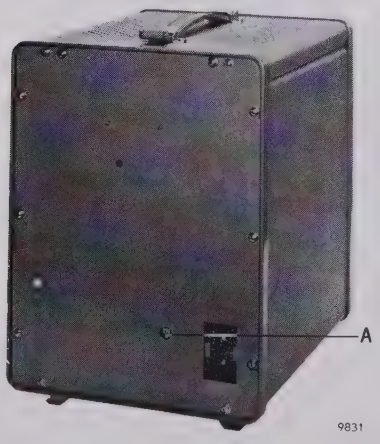


Fig. 2. Rear view

B. EARTHING

Earth the apparatus in accordance with local safety regulations. This can be done:

a. via one of the earth sockets at the front;
b. via the mains flex, if the apparatus is provided with a three-core mains flex fitted with a plug with rim earthing contacts, or
c. via the output cable of the object under test.

Double earthing connections must be avoided.

C. SWITCHING ON

- Make sure that the main voltage adapter is set to the correct value.
- Check the earthing of the apparatus.
- Set SK5 to position "0".
- Connect the apparatus to the mains.
- Switch on the apparatus by setting SK5 to position "POWER ON".

Operation

II

A. PRELIMINARY ADJUSTMENT

Set the varous controls provisionally to the following positions:
calibration knob (R1) about centre positions;

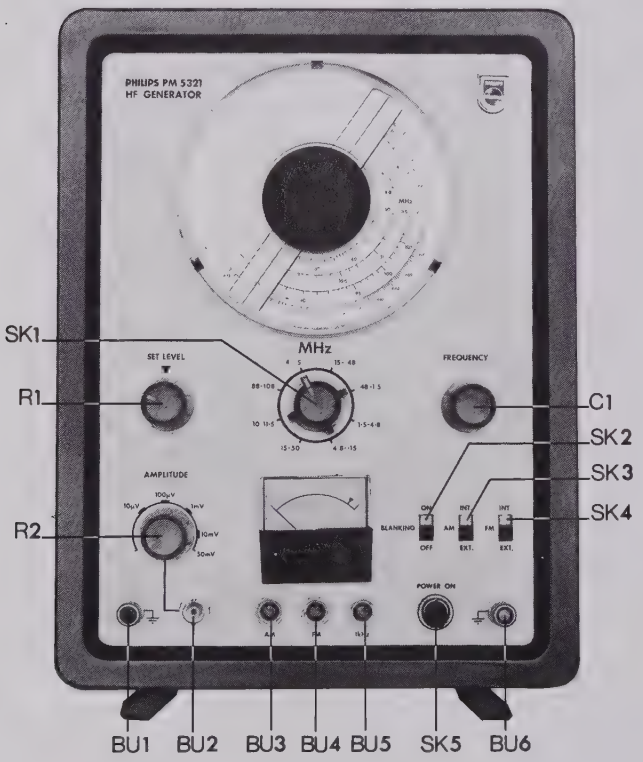


Fig. 3. Functions of the controls and sockets

R1 *calibration knob*
R2 *amplitude control*
C1 *frequency control*
SK1 *frequency range switch*
SK2 *blanking on/off switch*
SK3 *AM int/ext. switch*
SK4 *FM int/ext. switch*
SK5 *mains voltage on/off switch*
BU1 *earthing socket*
BU2 *HF output socket*
BU3 *AM input socket*
BU4 *FM input/50 c/s output socket*
BU5 *1,000 c/s output socket*
BU6 *earthing socket*

frequency control (C1)	arbitrary;
frequency band selector (SK1)	arbitrary;
amplitude control (R2)	approximately in its centre position;
AM selector (SK3)	"EXT";
FM selector (SK4)	"EXT";
Blanking (SK2)	"OFF".

Some time after switching on the pointer of the meter shows a deflection. Set the pointer at the calibration line by means of calibration knob R1 ("SET LEVEL"). Only if these requirements are met, the accuracy stated in the technical data holds good.

For the highest frequency range an output voltage of 50 mV is also obtainable. It is, however, possible that the pointer does not reach the calibration line.

B. FREQUENCY

The various frequency bands are adjusted by means of frequency-band selector SK1. Continuous control is effected with frequency control C1; this is also provided with a mechanical fine tuning. The frequency can be read off exactly from the large scale.
If the stated frequency accuracy is to be maintained, the pointer of the calibration meter must be set at the calibration line (as already stated).

C. AMPLITUDE

The output voltage is adjusted by means of the amplitude control (R2). After calibration, the output voltage amounts to 50 mV maximum.

D. MODULATION

Frequency modulation, internal as well as external, is possible in the frequency ranges of: **0.4–0.5 Mc/s** (AM-IF frequency).

Internal:

modulation with the aid of the mains frequency. The frequency sweep is 20 kc/s. A voltage having the mains frequency (10 $V_{r.m.s.}$), the phase of which can be adjusted, is then present on BU4.
This voltage can be used for the horizontal deflection of the oscilloscope.

External:

modulation with the aid of a voltage of 15 $V_{r.m.s.}$ for maximum sweep. Modulating frequency from 10 c/s to 5 kc/s.

10–11.5 Mc/s (FM-IF frequency)

Internal:

modulation with the aid of the mains frequency. The frequency sweep is 400 kc/s. A voltage having the mains frequency (10 $V_{r.m.s.}$), the phase of which can be adjusted, is then present on BU4. This voltage can be used for the horizontal deflection of the oscilloscope.

External:

The same as for the range of 0.4–0.5 Mc/s.

87.5–108 Mc/s (FM-band II)

Internal:

modulation by means of the 1,000 c/s voltage. The frequency sweep is 150 kc/s.
For horizontal deflection of the oscilloscope, the voltage on BU5 can be used (1,000 c/s–4 $V_{r.m.s.}$).

External:

The same as for the range of 0.4–0.5 Mc/s.

Amplitude modulation:

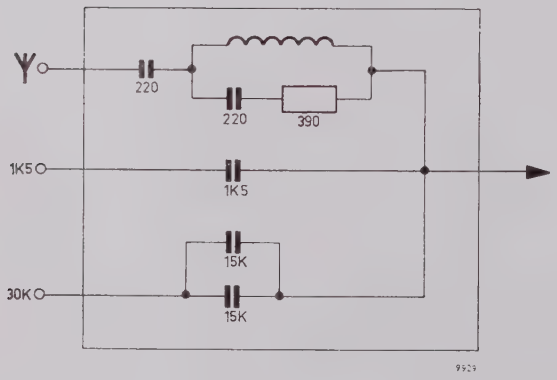
is possible internally (1,000 c/s, 30 %) as well as externally (20 c/s...20 kc/s, 5 $V_{r.m.s.}$ for 30 % modulation) for all ranges.

E. CONNECTING THE SIGNAL TO THE OBJECT UNDER TEST

The R.F. voltage is available at BU2. This socket is connected to the object under test by means of the measuring cable supplied; if necessary insert the dummy aerial or impedance transformer.

In the A.M. band the dummy aerial can be used to imitate the impedance of an A.M. aerial. In the F.M. band it is necessary to use the impedance transformer, which matches the output impedance of the oscillator to the input impedance of the receiver under test.

If one wants to apply the oscillator signal to a given part of the circuit, it will in many cases be useful to mount a 1,500-pF capacitor (present in the dummy aerial) in the supply lead, so as to block possible d.c. voltages.



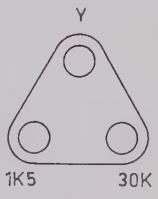


Fig. 4. Diagram of the dummy aerial 4822 210 70023

Application

III

A. THE VISUALISATION OF BAND-PASS CURVES

1. Introduction

In many cases it is desirable to know the shape of the band-pass curve in a given circuit. Usually the curve is measured statically i.e. point by point, which yields very reliable results but takes much time. This is more strongly in evidence in circumstances where the same measurement has to be performed several times. Moreover, one is mostly only interested in the shape of the band-pass curve and not in the absolute values it represents. In general, the so-called dynamic method will therefore be preferred. This method enables the band-pass curve to be displayed completely on the screen of an oscilloscope, thus offering the following important advantages:

- The speed at which each measurement is carried out is substantially increased.
- A possible change in the properties of the object under test is immediately recognized by the modified shape of the curve displayed on the oscilloscope. This is particularly useful during adjustment of radio or TV receivers, since one can find out without difficulty what effect each tuned circuit has on the band-pass curve of the whole.
- By introducing frequency marks it can be determined in an easy way what frequency is represented by a certain point of the oscillogram.

2. Principle (Fig. 5)

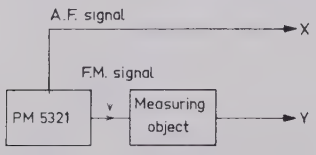


Fig. 5. Displaying band-pass curves

For carrying out the dynamic method a constant R.F. voltage which is modulated in frequency must be available. This signal must be fed to the object under test, which in most cases will be the I.F. amplifier of an A.M., FM or T.V. receiver. The central frequency and the frequency sweep of the

generator must be such that the entire frequency range of the I.F. amplifier is covered. The detector in the receiver will then produce a voltage whose amplitude varies, because the amplification differs for different frequencies. The form of the amplitude variation corresponds to the response characteristic of the amplifier. This voltage is fed to the vertical input of an oscilloscope.
A voltage which both in shape and frequency is equal to the modulation voltage is fed to the horizontal amplifier. This voltage can be derived from the generator.
The resultant curve on the screen of the oscilloscope (i.e. the band-pass curve) represents the amplitude as a function of the frequency. Practical uses of the principle discussed above are described in chapter III.B.

3. Frequency marks

Often one wishes to have a frequency mark, which can be moved through the entire F.M. intermediate frequency band. This wish can be met in a simple way, if the following additional equipment is available:

a marker oscillator (an accurate generator covering at least the frequency range 10–11.5 Mc/s);
a mixing circuit;
an L.F. amplifier.

A schematic survey of the principle is shown in Fig. 6. The way in which the band-pass curve arises has already been described previously and need not be discussed.
The signals of both the PM 5321 generator and the marker oscillator are applied to a mixing diode via the separator stages I and II. So the signal at the input of the mixing circuit (Fig. 7) is formed by superposition of the FM signal of the PM 5321 (with a central frequency f_1 of 10.7 Mc/s) and the unmodulated signal of the marker oscillator (with a frequency f_2 within the range of the PM 5321). In the mixing diode these two signals produce mixing products, the frequency components of which are formed by f_1, f_2, $(f_1 + f_2)$ and $(f_1 - f_2)$. An L.F. amplifier and a low-pass filter (Fig. 8) are connected after the mixing circuit. This combination selects from the many mixing products the component with the difference frequency. As soon as the frequencies of the two signals come sufficiently close together, their difference will produce an L.F. component which will be passed on by the amplifier/filter combination. At the moment that the two frequencies are equal the difference is zero, provided that they have

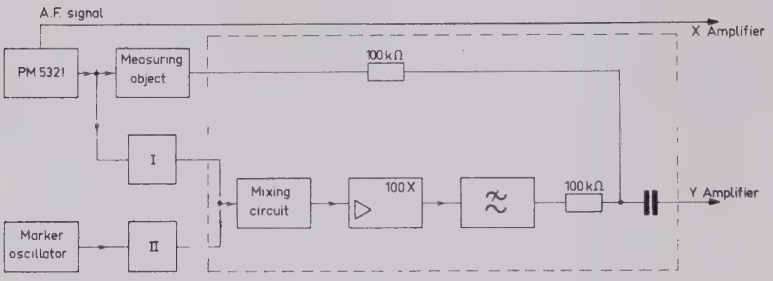


Fig. 6. Generating frequency markers

the same phase and the same amplitude. A moment later the frequencies deviate again from each other, so that another L.F. component is formed. Consequently, one would expert that the pulse obtained will have the shape of Fig. 9. That this is not the case is caused by the following. Owing to the frequency drift of the two generators with respect to each other their phase will shift continuously, so that the condition for obtaining a difference product zero is no longer met. The output voltage of the mixing circuit has become variable i.e. fluctuates with the phase shift. Although to a lesser degree, the afore mentioned also applies to all difference frequencies produced. So the resultant pulse from the mixing circuit has a very irregular character. This has however, no adverse effect on the quality of the mark. In general, the bandwidth of the pulse obtained is too large and the amplitude too small, but this is improved by the L.F. amplifier (e.g. PM6045) and the low - pass filter, both of which are circuited after the mixing circuit. The resultant output pulse is shown in Fig. 10.

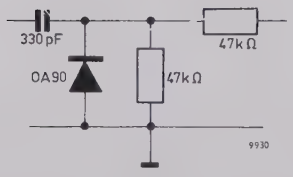


Fig. 7. Mixing circuit

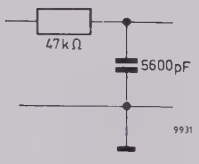


Fig. 8. Low-pass filter

The marking pulse is added to the voltage from the object under test via an adding circuit and fed to the Y amplifier of the oscilloscope. The amplitude ratio of mark and band-pass curve is adjusted by varying the amplitude of the marking signal or by adjusting the amplification of the marker amplifier. The mark can be shifted with respect to the band-pass curve by varying the frequency of the marker oscillator.

In conclusion a few remarks on the practical design of the apparatus. The separator stages I and II (Fig. 6) have a double function. Firstly they prevent the two generators from affecting one another and secondly they prevent the signal of the marker oscillator from being fed to the object under test. For this purpose cathode or emitter followers will satisfy best. In many cases complete suppression of unwanted signals is not strictly necessary. These cathode or emitter followers may then be replaced by resistors of 330 Ω.

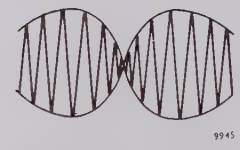


Fig. 9. Mixing product

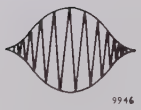


Fig. 10. Marking pulse

B. ADJUSTMENT OF A.F., F.M. AND TV RECEIVERS

In the following sections a number of practical cases will be dealt with. Discussed consecutively are:

1. Adjustment of an A.M. receiver;
2. Adjustment of an F.M. receiver (static method);
3. Adjustment of an F.M. receiver by means of a cathode-ray oscilloscope (dynamic method);
4. Adjustment of the IF amplifier in a T.V. receiver (static method).

The data given should be completed with those from the service data of the relevant receiver.

Important!

- For measurements on universal receivers (suitable for both a.c. and d.c. voltage supply) it is necessary that the mains voltage connection be effected via a separating transformer. It is not permitted to connect several apparatuses to this transformer at the same time.
- Connect the chassis of the receiver to a good earth.
- To ensure good frequency accuracy and stability it is recommended to switch on the generator half an hour before adjustment is started.
- As the AGC voltage influences the amplification of the circuit, this voltage has to be replaced by a fixed level, for example from a battery.

If the set under test has a delayed AGC, one can use a small input signal, without interrupting the AGC line.

1. Adjustment of an A.M. receiver

a. Measuring equipment to be used

A.C. voltmeter: e.g. PHILIPS GM 6001, P 817 00, PM 2400, PM 2411
Signal generator: PM 5321
Battery

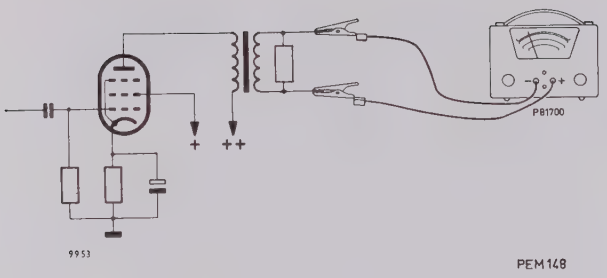


Fig. 11. Connecting the a.c. voltage meter to a receiver with a low output impedance

b. General

1. The a.c. voltage meter is connected in accordance with Fig. 11 or 12, depending upon the output circuit of the receiver.

Connection in accordance with Fig. 11

Unsolder the leads of the loudspeaker and replace them by a resistor of 5 Ω. Connect the a.c. voltmeter to the extra loudspeaker input (if present) or to the secondary of the output transformer. Adjust the a.c. voltmeter to a measuring range of approx. 3 V∼.

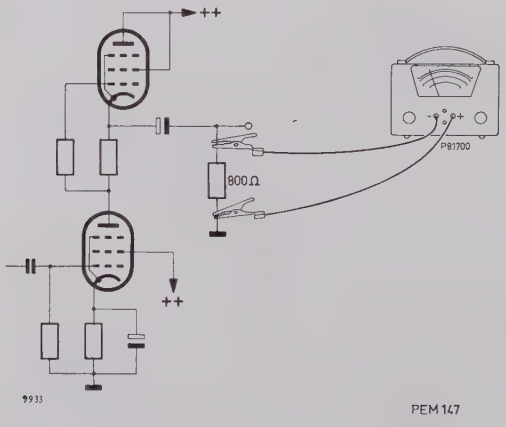


Fig. 12. Connecting the a.c. voltage meter to a receiver with a high output impedance

Connection in accordance with Fig. 12.

Unsolder the leads of the loudspeaker and replace them by a resistor of 800 Ω. Connect the a.c. voltmeter to this resistor. At the beginning of the adjustment set the meter to a measuring range of approx. 100 V~.
In case of several loudspeakers the meter must be connected to the bass channel.

2. Set the controls of the receiver to the following positions:
   volume control: maximum;
   bass control: maximum;
   treble control: maximum;
   bandwidth control: "minimum bandwidth".

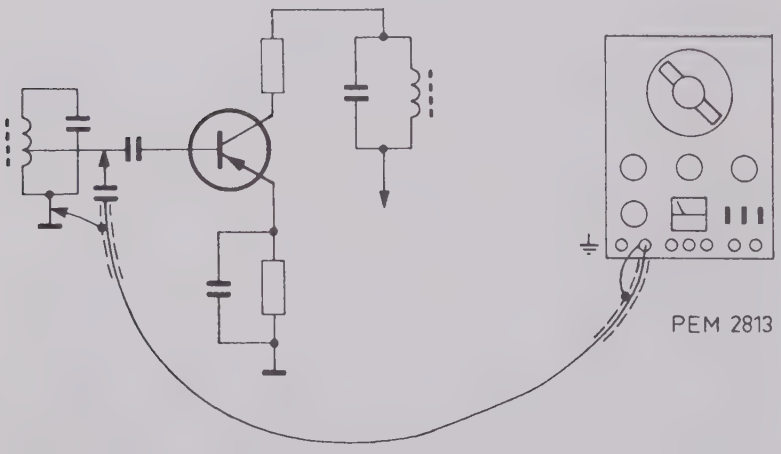


Fig. 13. Static adjustment of an A.M. receiver

c. I.F. band-pass filters

1. Connect the PM 5321 generator to the valve connection indicated in the trimming table of the service data (Fig. 13) via the 30,000 pF capacitor in the dummy aerial.

2. Adjust the frequency of the PM 5321 generator to the intermediate frequency of the receiver. Increase the output voltage to maximum.
3. Set the tuning capacitor of the receiver to minimum capacity.
4. Set the range switch to medium wave.
5. If the receiver has a ferroceptor: short-circuit the medium-wave ferroceptor coil.
6. Screw out the cores of I.F. band-pass filters, rejector and absorption circuits as far as possible.
7. Adjust the cores of the I.F. band-pass filters so that the a.c. voltmeter shows maximum deflection, in the sequence indicated in the trimming table. During trimming, the output voltage of the generator must be decreased continuously in such a way, that the voltage at the a.c. voltmeter does not exceed the value indicated under "General".

d. Dynamic test of the I.F. curve

Extra measuring instrument required: oscilloscope GM 5600, PM 3201, PM 3200 or PM 3230.

1. Connect the vertical amplifier of the oscilloscope to the volume control (Fig. 14):

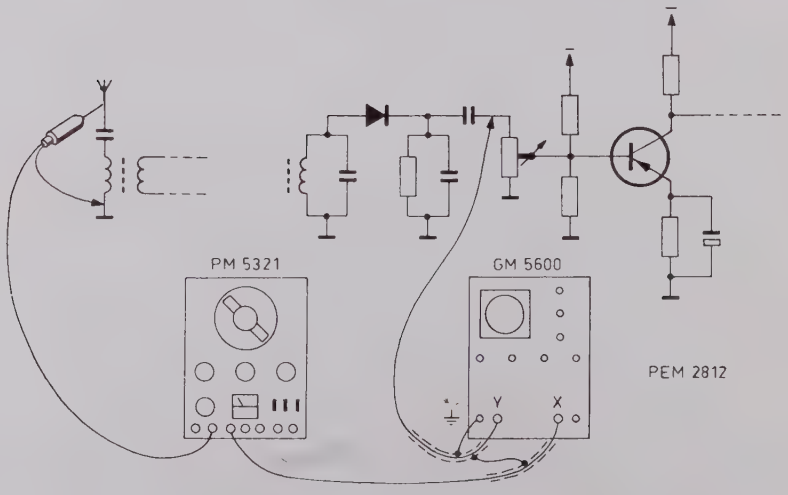


Fig. 14. Dynamic check of the I.F. curve

2. Connect the horizontal amplifier to socket "FM" of the PM 5321.
3. Set the F.M. selector to the position "INT."
4. On the screen of the oscilloscope a band-pass curve will appear of the shape shown in Fig. 15.

e. I.F. rejector and absorption circuits

1. Adjust the output voltage of the generator to maximum.
2. Connect the generator both to the aerial socket and the chassis of the receiver via the dummy aerial with the apparatus.
3. Set the range switch to medium wave.
4. If the receiver has a ferroceptor: short-circuit the medium wave ferroceptor coil.
5. Screw out the cores of the I.F. rejector and absorption circuits as far as possible.
6. Adjust the cores of the rejector and absorption circuits so that the a.c. voltmeter shows minimum deflection.

f. R.F. and oscillator circuits

In adjusting R.F. and oscillator circuits use is made of trimming points on the dial.

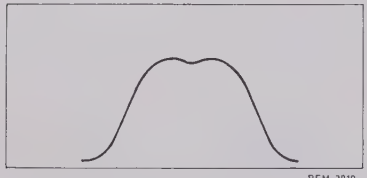


Fig. 15. I.F. curve of an A.M. receiver

1. Connect the generator to the aerial socket and the chassis of the receiver via the dummy aerial.
2. Set the range switch to the wave range to be adjusted.
3. Adjust the pointer to the trimming point indicated in the service data by means of the tuning knob.
4. Adjust the generator to the frequency required for this trimming point (mentioned in the service data).
5. Adjust the cores and/or trimmers of R.F. and oscillator circuits to maximum deflection of the a.c. voltmeter. During trimming, the output voltage of the generator must be decreased continuously in such a way, that the output voltage does not exceed the value indicated under "General".
6. Repeat points 3 to 5 for each wave range.

2. Static adjustment of an F.M. receiver

a. Measuring instrument to be used

Valve voltmeter: e.g. PHILIPS GM 6000, GM 6001, PM 2401 or PM 2400

b. General

Adjustment of the secondary circuit of the last IF band-pass filter:

Connect the valve voltmeter in accordance with Fig. 16. The two auxiliary resistors R4 and R5 may have a value of about 220 kΩ and must be equal to one another as far as possible. For this purpose use should be made of 1 % resistors or two specially selected ones (check with an accurate ohmmeter or measuring bridge, e.g. GM 4144).
Adjust the valve voltmeter to a measuring range of –3 V d.c.

Adjustment of the other circuits: connect the valve voltmeter to electrolytic capacitor C2 in Fig. 17. Set the valve voltmeter to a measuring range of –3 V d.c.

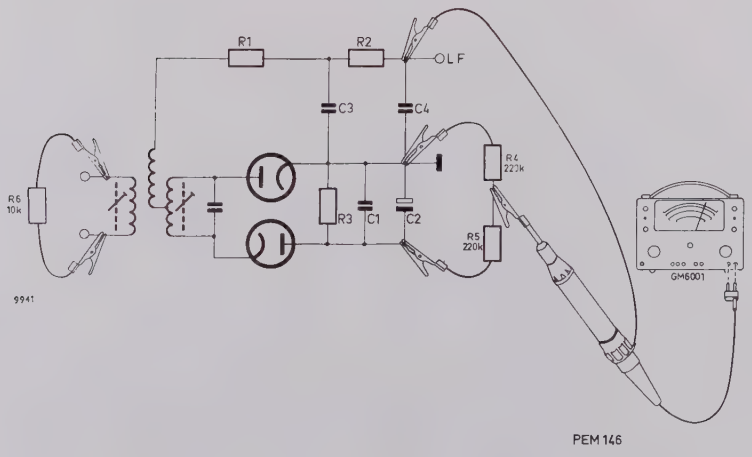


Fig. 16. Adjustment of the F.M. discriminator

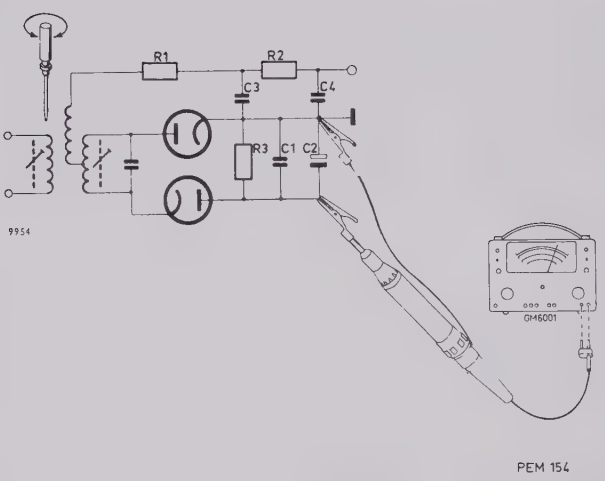


Fig. 17. Adjustment of the I.F. circuits

c. I.F. band-pass filters

1. Turn the volume control to minimum volume.
2. Turn the tuning capacitor to maximum capacity or – in the case of inductive tuning – turn the cores of the tuning coils to maximum inductance.
3. Set the range switch to F.M.
4. Screw out the cores of the I.F. band-pass filters as far as possible.
5. Connect generator PM 5321 to the valve connection indicated in the service data of the receiver, via the 1,500-pF capacitor in the dummy aerial.
6. Adjust the core of the primary circuit (Fig. 17) of the last IF band-pass filter (ratio detector) to maximum deflection of the valve voltmeter. In doing so, adjust the output voltage of the generator continuously in such a way that the deflection of the valve voltmeter does not exceed –3 V.
7. Terminate the primary circuit of the last I.F. band-pass filter with a resistor of approx. 10 kΩ (R6 in Fig. 16). Adjust the core of the secondary circuit to minimum deflection of the valve voltmeter (connected in accordance with Fig. 16).
   Note: If the probe is removed from the voltmeter, the position of the pointer must not change.

8. Adjust the cores of the other I.F. band-pass filters in the sequence indicated in the service data of the receiver. After adjustment of one of the circuits of a band-pass filter this circuit should be terminated with a resistor of approx. 10 kΩ, after which the other circuit of the band-pass filter can be adjusted (Fig. 18).
   Meanwhile the output voltage of the signal generator must be adjusted continuously in such a way that the valve voltmeter does not indicate more than –3 V.

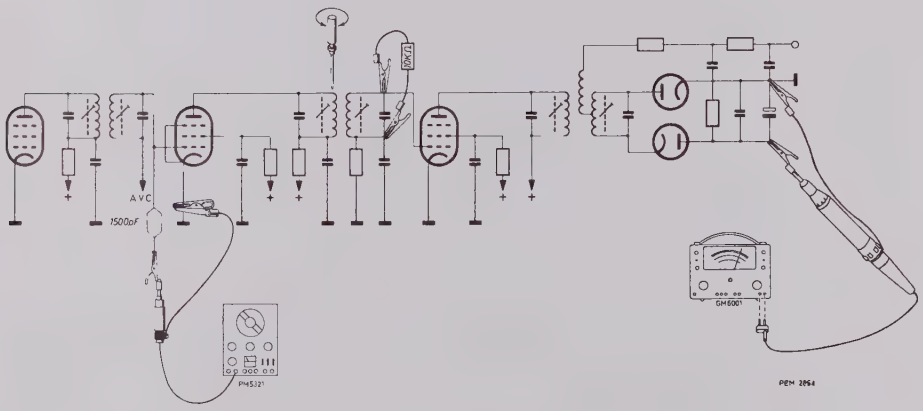


Fig. 18. Alternately damping and adjusting the primary and secondary circuits

d. R.F. and oscillator circuits

1. Connect the valve voltmeter across electrolytic capacitor C2 (Fig. 17). Adjust to a measuring range of –3 V d.c.
2. Connect generator PM 5321 between one of the F.M. aerial sockets and the chassis.
3. Set the volume control of the receiver to zero.
4. Set the range switch to F.M.

5. Turn the tuning capacitor to minimum capacity or – in the case of inductive tuning – turn the cores of the tuning coils to minimum inductance (fully screwed out). Adjust the pointer to the mark on the extreme left of the dial.
6. By means of the tuning knob adjust the pointer to the frequency indicated in the trimming table of the receiver.
7. Adjust the frequency of the generator to the value indicated in the trimming table.
8. Adjust the cores of the R.F. and oscillator circuits to maximum deflection of the valve voltmeter in the sequence mentioned in the trimming table. In doing so, adjust the output voltage of the signal generator continuously in such a way that the voltage on the valve voltmeter remains always less than –3 V.
9. For further particulars, reference is made to the description of the relevant tuning unit.

3. Dynamic adjustment of an F.M. receiver

a. Measuring instruments to be used

1. F.M. generator: PM 5321
2. Cathody-ray oscilloscope: e.g. GM 5600, PM 3201, PM 3200 or PM 3230
3. Valve voltmeter: e.g. PM 2401, GM 6001, PM 2400
4. A.c. voltage meter: e.g. P 817 00, PM 2411

b. Connecting the measuring instruments (see Fig. 19)

1. Connect the valve voltmeter across resistor R3 of the detector circuit via a resistor of 0.1 MΩ (R4 in Fig. 19). Adjust the voltmeter to a measuring range of –3 V d.c.
2. Connect the vertical amplifier of the oscilloscope to resistor R3 via a resistor of 0.1 MΩ (R5). Connect the horizontal amplifier to socket "FM" of the PM 5321.
3. Adjust the generator to 10.7 Mc/s (frequency range 10 – 11.5 Mc/s). Set the F.M. switch to position "INT". Adjust the controls of the oscilloscope for horizontal and vertical shift and horizontal amplification in such a way that the line on the screen is symmetrical with respect to the vertical centre axis of the square (so in Fig. 20 AB = BC). Point B on the screen will now represent a frequency of 10.7 Mc/s. **During adjustment, this setting must not be changed!**

4. Connect the a.c. voltage meter as indicated in chapter *"Adjustment of an AM receiver, General"*.

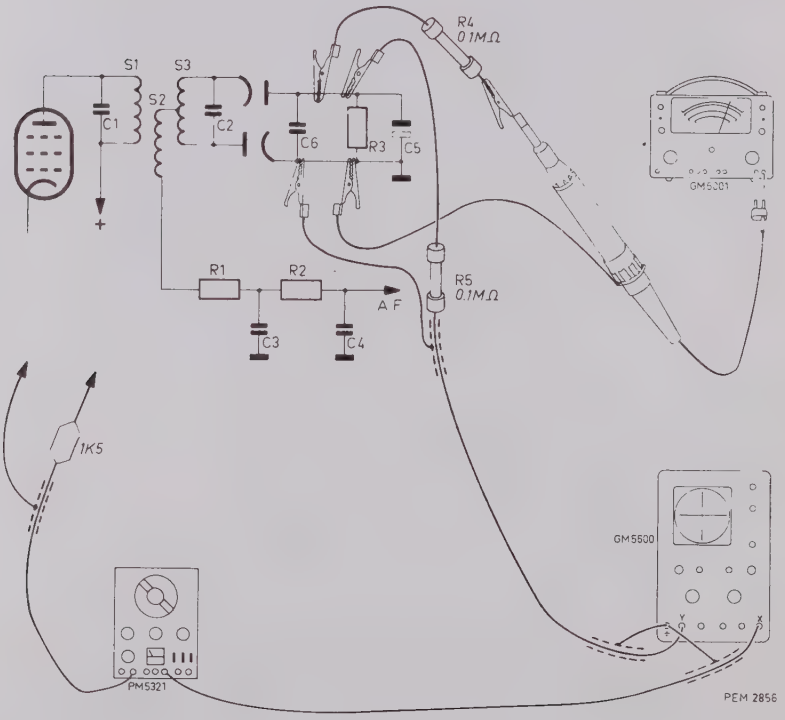


Fig. 19. Dynamic adjustment of an F.M. receiver

c. IF band-pass filters

1. Connect the generator to the valve connection indicated in the trimming table of the receiver. In order to prevent strong distortion of the band-pass curve to be displayed, the earth socket of the generator must be connected to the chassis, in the immediate vicinity of the valve to which the signal is fed.
2. Set the volume control of the receiver to minimum volume.

3. Turn the tuning capacitor to maximum capacity or – in the case of inductive tuning – turn the cores of the tuning coils to maximum inductance (fully screwed in).
4. Set the range switch to F.M.
5. Screw out the cores of the I.F. band-pass filters as far as possible.
6. Unsolder the electrolytic capacitor in the ratio-detector circuit (C5 in Fig. 19).
7. Adjust the core of the *primary* circuit of the last I.F. band-pass filter (ratio detector) to maximum height of the band-pass curve. The amplitude of the R.F. signal must be adjusted continuously in such a way that the valve voltmeter indicates approximately —3 V.
   When the BLANKING switch is in position "OFF", the picture is displayed twice per period of the time base, with the result that the two curves need not completely coincide on the screen. Both curves can be made to coincide with the aid of the phase adjusting potentiometer on the rear of the generator. If the blanking is switched on (switch in position "ON"), only one curve is displayed.
   The displayed curve must be symmetrical with respect to the line EF, so that the top of the curve (corresponding to 10.7 Mc/s) is on this line (Fig. 21).

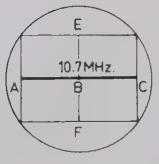


Fig. 20. Frequency scale

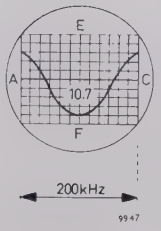


Fig. 21. I.F. curve during the adjustment

8. Set the volume control to maximum volume.
9. Now connect again the electrolytic capacitor (C5, Fig. 19). Adjust the core of the secondary circuit of the last I.F. band-pass filter (discriminator) to maximum deflection of the a.c. voltage meter. The deflection of the valve voltmeter must be less than —3 V, so that the output voltage of the generator must be decreased if necessary.
   Checking the discriminator curve – Connect the oscilloscope across capacitor C4 (Fig. 19). The centre of the straight part of the displayed curve must be on the line EF (Fig. 23). If the curve has an asymmetrical or non-linear shape, repeat points 6...9).
10. Unsolder the electrolytic capacitor (C5 in Fig. 19). Adjust the cores of the other band-pass filters to maximum height of the curve in the sequence indicated in the trimming table (Fig. 22, curve I). In doing so, the band-pass curve must always be symmetrical with respect to the middle of the screen (Fig. 22, line EF, curve II).
    During setting, the output voltage of the generator must be adjusted in such a way that the voltage on the valve voltmeter is always approximately —3 V.
11. *Checking the A.M. suppression* – Resolder the electrolytic capacitor (C5, Fig. 19). Set the A.M. switch (SK3) of the PM 5321 to "INT.". The wave-form on the oscilloscope will now show a sinusoidal modulation, the amplitude of which varies from zero (in the middle of the discriminator curve) to a certain value (at the end of the straight part). The A.M. suppression is sufficient, if the latter amplitude is smaller than 1/10 of the height of the curve.

Fig. 22. I.F. curve in two stages of adjustment

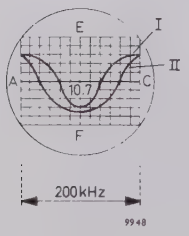
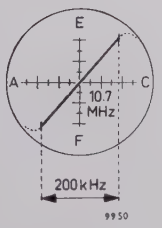


Fig. 23. Discriminator curve



d. RF and oscillator circuits

1. Connect the valve voltmeter across resistor R3 of the discriminator circuit, via a resistor of 0.1 MΩ (R4 in Fig. 19). Adjust the measuring range of the valve voltmeter to —3 V d.c.
2. Connect generator PM 5321 to the F.M. aerial sockets (Fig. 24) via the impedance transformer.

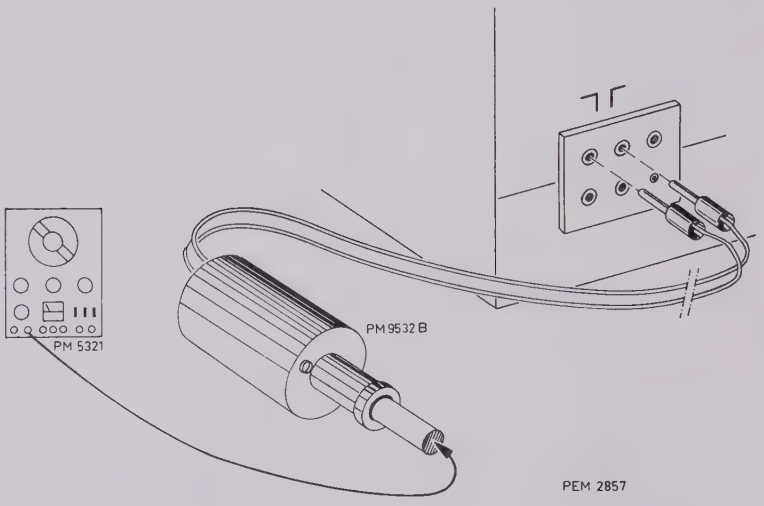


Fig. 24. Connections for adjusting the R.F. and oscillator circuits

3. Turn the volume control to minimum volume.
4. Set the range switch to F.M.
5. Adjust the tuning capacitor to minimum capacity or – in the case of inductive tuning – adjust the cores to minimum inductance (fully screwed out).
   Adjust the pointer of the receiver to the mark on the extreme left of the dial.
6. By means of the tuning knob adjust the pointer to the frequency indicated in the trimming table.
7. Adjust the frequency of the generator to the frequency indicated in the trimming table.
8. Adjust the cores of the R.F. and oscillator circuits to maximum deflection of the valve voltmeter, in the sequence indicated in the trimming table.
   The voltage on the valve voltmeter must not exceed —3 V, so that the

amplitude of the generator voltage must always be adapted to this requirement.

9. For further particulars reference is made to the description of the relevant tuning unit.

4. Static adjustment of television I.F. circuits

The I.F. amplifier of a TV receiver must meet the following requirements (see Fig. 25):

1. The band-pass curve should be such that it has a correcting effect on the frequency response curve of the transmitter signal, in which the low frequencies have the advantage with respect to the high frequencies.
   This implies, amongst others, that the carrier of the picture signal has to be attenuated by a factor 2.
2. The sound carrier must be attenuated as follows: in inter-carrier receivers 12 to 20 times (f2), in separated carrier receivers 200 times (f3).
3. Finally, complete suppression must take place of the sound carrier in the adjacent higher channel (f4) and of the image carrier in the adjacent lower channel (f5).

a. Measuring instruments to be used

R.F. signal generator PM 5321;
electronic voltmeter GM 6001, PM 2400
battery with low internal resistance.

Important

Many TV apparatuses have no supply transformer, so that the chassis can be at mains voltage. It is therefore necessary that the mains voltage connection is effected via a blocking transformer. This transformer must have a capacitance of at least 250 VA. Connect the chassis of the receiver to a good earth.

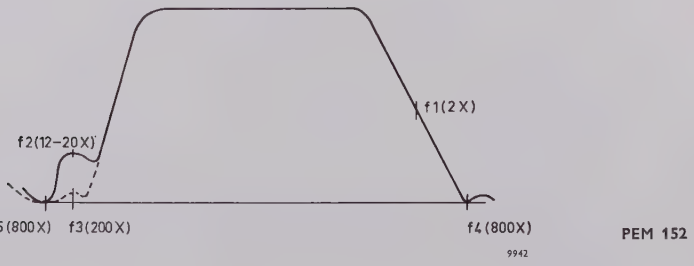


Fig. 25. Band-pass curve of the I.F. amplifier of a TV receiver

b. Preliminary adjustment

RF signal generator (Fig. 26)

1. Switch on the generator approximately half an hour before adjustment is started.
2. Set the frequency-band selector (SK1) to position "15 – 50 MHz". Adjust the frequency to the intermediate frequency (the intermediate frequencies are mentioned in the service documentation of the relevant TV apparatus).
3. Set the A.M. switch (SK3) to "INT.".
4. Connect the generator to measuring point M2 of the channel selector (for accurate information concerning this measuring point the service documentation of the TV receiver should be consulted).
   Connect the screening of the cable to a place of the chassis which is as close as possible to measuring point M2. This earth connection must be as short as possible.
5. Turn the amplitude control fully anti-clockwise.

Valve voltmeter (Fig. 26)

1. Connect a filter consisting of R5 (5.6 kΩ) and C5 (1,500 pF) between the anode of the video output valve and earth.
2. Connect the valve voltmeter across capacitor C1. Set the voltmeter to 3 V~.
   The voltmeter is included in the anode circuit in order to prevent interference of the tuning of the last I.F. band-pass filter.
   The low-pass filter R5 – C5 suppresses the high frequencies, but not the detected voltage of 1000 c/s.

Battery (Fig. 26)

The battery is used to adjust the AGC voltage of the receiver to a fixed value. This pseudo-AGC voltage is adjusted with a potentiometer of 1 kΩ (R6), connected in parallel to the battery. If the voltage of one battery is not sufficient, two or more batteries can be connected in series.

1. Connect the positive pole of the battery to the chassis of the receiver.
2. Connect the negative pole (the rotary contact of potentiometer R6) to capacitor C2 (the point to which the negative pole must be connected as indicated in the service documentation of the TV receiver).

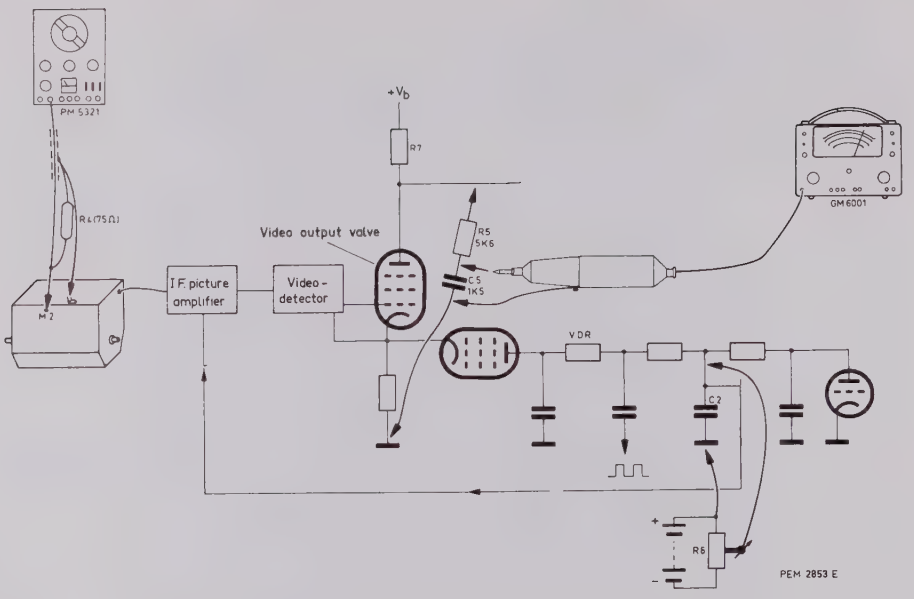


Fig. 26. Connection of the various instruments to a TV receiver

3. Adjust the pseudo-AGC voltage to the value stated in the service documentation of the TV receiver.

TV receiver

1. Owing to its low impedance for intermediate frequencies the R.F. band-pass filter, which is found between cascode circuit and mixing valve in the channel selector, exerts a disturbing influence on the terminal resistance of the generator cable. This influence must be eliminated by switching off the band-pass filter:
   Set the channel selector to a free channel or to a position in between two channels.
2. Set the contrast control of the TV receiver to maximum contrast.
3. The signal of the generator must have such an amplitude that the TV receiver is not overmodulated. In order to check this, the amplitude of the R.F. signal is increased slowly. As long as the receiver is not overmodulated, the pointer deflection of the voltmeter will also increase. However, as soon as overmodulation occurs, the pointer deflection no longer increases; with a further increase of the amplitude

the pointer will even move back. During adjustment, the amplitude control of the generator is adjusted in such a way that the pointer of the voltmeter shows a clearly visible deflection in the 3 V range.

c. Adjustment

The service documentation of TV receivers contains a trimming table with data about the adjusting sequence of the various circuits, the frequencies to be adjusted, adjustment to maximum or minimum deflection etc. These instructions must be carefully observed.
Sometimes it is stated in the trimming table that the band-pass filter must be adjusted twice: once without and once with damping filter. This method has the advantage that at the beginning of the final adjustment the band-pass filters are already adjusted to approximately the correct frequency. A lay-out of the damping filter is given in the service documentation of the TV receiver. Unless otherwise stated, the damping filter is always connected between earth and the point to be damped.

d. Practical suggestions

A description is given below of measures to be taken in the event of faults.

During adjustment of an absorption circuit the deflection of the pointer is insufficient to find the required minimum: The pseudo-AGC voltage is removed provisionally and the maximum available R.F. voltage is applied to measuring point M2 (see the relevant service documentation).

The pointer of the valve voltmeter does not stand still, but oscillates slowly: This phenomenon is due to a small difference between frame and mains frequency. In most cases it is sufficient to turn the frame-synchronizing control slightly. If this is not the case, an improvement may be achieved by switching off the frame oscillator. For instance, remove the supply voltage of the frame oscillator and, in doing so, do not forget to turn back the brightness control. Should the pointer still oscillate, then the hum voltage on the anode of the video output valve is too large and the supply voltage + Vb (Fig. 26) must be extra decoupled with an electrolytic capacitor of 1,000 μF (4×250 μF in parallel).

SERVICE DATA

Circuit description

A. R.F. OSCILLATOR

This employs a double triode B2–B2′ oscillating in a balanced push-pull connection. Such a circuit has negligible harmonic distortion.
The eight oscillator coils L1...L8 are completely enclosed with the oscillator in a separate metal case with access for alignment. (For the frequency ranges see the technical data). The frequency ranges 10–11.5 Mc/s and 88–108 Mc/s are expanded by connecting C16 and C18 in series with each half of C1, respectively, and the range 0.4–0.5 Mc/s is expanded by having C36 and C37 each connected in parallel with C16 and C18 respectively. The output voltage is maintained constant at any desired frequency by setting the pointer of the diode voltmeter (C21, GR2, R35, R36 and ME) to the calibration line with R1. It is recommended to maintain this setting during use, as large deviations from the calibration line might affect the frequency. R1 controls the mean anode voltages of B2 and B2′, thus regulating the amplitude of oscillation. The maximum output is 50 mV when the pointer is set to the calibration line. (The meter is calibrated by selection of R35.) For the highest frequency range the output voltage of 50 mV is obtainable too, however, it is possible that the pointer does not reach the calibration line.

B. AMPLITUDE MODULATOR-BUFFER

The output voltage of the H.F. oscillator is applied to the control grid of valve B3 via C22. The modulating voltage is applied to the third grid of this valve. When switch "AM" (SK3) is in position "INT.", the 1,000 c/s signal of the RC oscillator (B1) is applied to the suppressor grid of B3. The value of this voltage, and consequently also the modulation depth of the H.F. output signal, can be adjusted with the aid of R20. External modulation is possible as soon as switch "AM" is set to position "EXT.". BU3 ("AM") is then interconnected to g3 of the modulator valve via C54. This valve also acts as a buffer between oscillator and output. The network formed by C27, R41, C28 and R2 filters the L.F. component out of the output voltage.

C. FREQUENCY MODULATOR

The following components offer the possibility of frequency modulation:
in the range of 10–11.5 Mc/s: GR1 and C12;
in the range of 88–108 Mc/s: GR3 and C13;
in the range of 0.4–0.5 Mc/s: GR4 and C14.
A linear modulation is obtained by varying the setting of diode GR1 (GR3 or GR4 respectively) with the aid of a voltage having the mains frequency, or the 1 kc/s signal of B1.
This variation of the conductivity in the diode causes a varying capacitive impedance across one half of the tuned circuit.
Capacitors C12, C13, C14 determine the frequency sweep for the three ranges.

D. A.M. AND F.M.

As explained amplitude modulation can be switched on with SK3 independently of SK4. This enables a frequency-modulated signal to be amplitude-modulated so that the A.M. rejection of an F.M. receiver can be checked.

E. HORIZONTAL DEFLECTION VOLTAGES FOR AN OSCILLOSCOPE

In order to display I.F. response characteristics and discriminator characteristics on the screen of an oscilloscope, a voltage at mains frequency having an adjustable phase is available on BU4.
Although the 1-kc/s voltage is also available it is unlikely that it would be used for a similar display, and therefore means to adjust the phase have been omitted.

F. 1-kc/s OSCILLATOR

The 1-kc/s voltage required for frequency and amplitude modulation (via R14 and R20 respectively) is generated by an RC phase-shift oscillator consisting of valve B1, which has feedback from anode the control grid via C7–R22–C9–R23–C10 and R24. This network provides a phase shift of 180° at 1 kc/s causing the valve to oscillate at that frequency.

G. BLANKING

Modulation with a sinusoidal voltage causes the frequency sweep to be completed twice per period.
In the frequency ranges of 10–11.5 and 0.4–0.5 Mc/s this can be prevented by blanking the modulated signal during half a period. A 50 c/s signal, coming from transformer T1, is applied to the clipper circuit formed by TS1 via SK2 (in position "ON"). As a result, negative half sine-waves arise on the first grid of B3 which cut off this valve. As the modulation voltage has been phase shifted 90° with respect to the blanking voltage by means of potentiometer R5, the remaining H.F. signal will complete exactly one full frequency sweep. The blanking can be switched off by setting SK2 to position "OFF".

H. STABILISED POWER SUPPLY

The power unit is a conventional stabilising circuit, having B502 as a series regulator and B502′ as control valve with B503 providing the reference potential. The output voltage is adjusted to the correct value by selection of R510.

I. IMPEDANCE TRANSFORMER PM 9532 B

The transformer unit is provided to match the 75-Ω unbalanced output impedance of the oscillator to a 300-Ω balanced load of, say, standard twin feeder.
The unit contains a transformer with two isolated windings (turns ratio 1 : 1) to convert an unbalanced to a balanced connection, and a set of matching resistors to provide the correct input/output impedances.

Principle – The impedance transformation can generally be obtained with a transformer having a suitable turns ratio, but in this case the frequency range is large and so is the effect of stray capacity etc.; therefore a ferrite-cored transformer with a turns ratio of unity is employed. The resistance network R1, R2 and R3 (Fig. 27) not only provides impedance matching but R2 and R3 are proportioned such that the resistances to

earth from each side of S1 are equal; thus both transformer windings are balanced with respect to earth.
The equivalent circuit for the impedance transformer as connected between PM 5321 and a 300-Ω load is shown in Fig. 28.

Attenuation – The voltage attenuation from a 75-Ω source to a 300-Ω load (Fig. 28) is:

$$\frac{300 + 150 + 110}{300} = 1.9 \text{ times or } 5.5 \text{ dB.}$$

The maximum working voltage is 2 Vp-p.

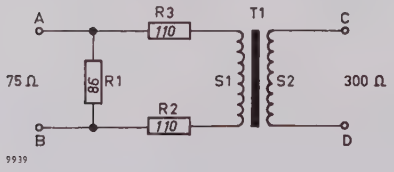


Fig. 27. Impedance transformer PM 9532 B

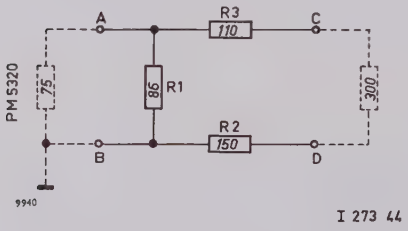


Fig. 28. Equivalent circuit of the impedance transformer

K. DUMMY AERIAL 4822 210 70023

The dummy aerial serves to substitute the impedance of a real A.M. aerial.
The dummy aerial consists of a parallel circuit (C100, R100 and L100) connected in series with capacitor C101 (see Fig. 29).
If a service oscillator is connected to the aerial input of a receiver to be checked or adjusted, the dummy aerial must be used as a coupling element; connect the measuring cable of the oscillator to socket "Y".

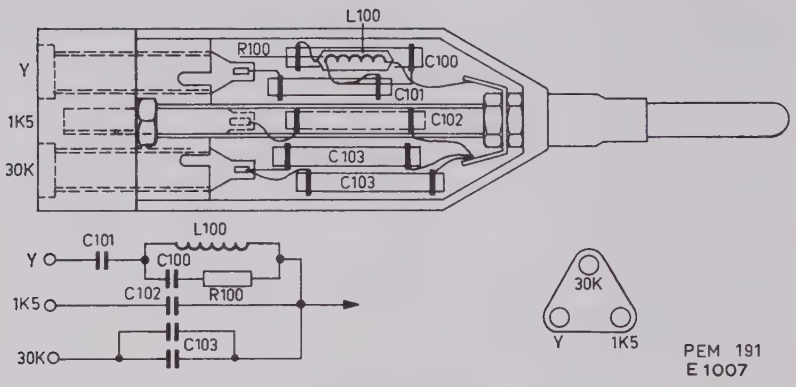


Fig. 29. Equivalent circuit of the dummy aerial

Now the aerial circuit of the receiver is correctly matched for all frequencies. Thus detuning is avoided and a correct adjustment has become possible. Moreover the dummy aerial is provided with two sockets ("1K5" and "30K") allowing the signal required for the adjustment of the I.F. circuits of A.M. and F.M. receivers to be applied directly to the control grid of the valve concerned.

Maintenance

II

A. SEGMENT SWITCHES

If the switch contacts fail to function properly, they can be lubricated with a special oil (see list of mechanical parts). This oil has cleaning and lubricating properties. After lubrication the switch should be rotated a few times.

B. CABINET PANELS

If the plastic covered panels become dirty, they can be washed with soap and water, and if necessary scouring powder can be used. (For removing the panels see section III.A.)

Gaining access to, and replacing parts

A. REMOVING THE CABINET PANELS (see Fig. 38)

The cabinet consists of 6 panels which can be removed separately.

1. Rear panel

- Loosen and remove the 6 screws "A".

2. Side panels and top panel

- Loosen and remove 2 screws "B" securing the panel
- Push the panel forward and lift it out of the frame.

3. Bottom panel

- Remove 4 screws and the two feet.

B. REMOVING THE KNOBS (see Fig. 30)

- Remove cap "A"
- Loosen the nut (or screw) "B". The knob can then be removed from the spindle.
  If the knob is jammed, press the screw with a screw driver while pulling the knob so that the clamping cone is released.

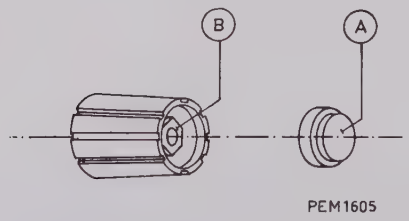


Fig. 30. Removing the knobs

C. REPLACING THE THERMAL FUSE (see Fig. 34)

The fuse blows when the temperature of the supply transformer becomes too high (> 125 °C)

- Remove the bottom panel and right-hand side panel.
- Hook a new fuse on to the spring and over the hook on the transformer.

D. REMOVING THE FRONT PANEL

For changing R1, SK2, SK3, SK4, SK5, the driving cord, and the meter etc.

- Remove the two side, the top and the bottom panels.
- Unsolder the two earth connections.
- Remove the knobs and loosen the centre screw of the frequency dial.
- Remove the nuts of SK5, BU3, BU4, BU5, and the terminals of the meter.
- Remove the 8 corner screws. The front assembly can now be slid forward.

E. FITTING A NEW DRIVING CORD (see Fig. 31)

The nylon driving cord is 370 mm long with a small loop at each end.

- Remove the front panel (see section D).
- Turn the shaft of C1 fully anti-clockwise.

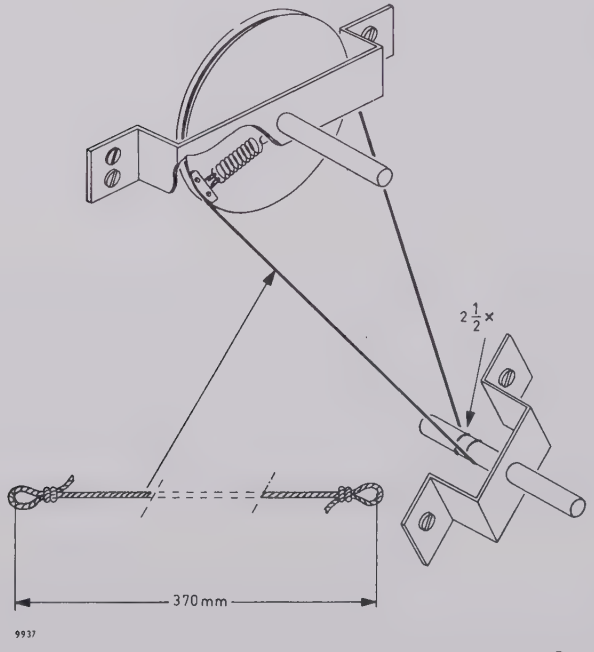


Fig. 31. Scale drive

- Hook one loop on the spring, take the free end down and round the driving shaft $2\frac{1}{2}$ turns.
- Hook the other end of the cord on the spring.
- Turn the pulley 180°; the cord will fall in the groove in the pulley.

When roughly re-locating the pointer on the frequency scale, note that the frequency decreases when the tuning knob is turned clockwise, and also the pointer is horizontal and coincident with a line marked between the scales at both extremes. Check against a standard oscillator to set the pointer exactly.

F. REMOVING THE SCREENING PLATES ON THE TUNING TANK

- Remove the top plate by unscrewing the 2 screws on each side, 3 at the front and 3 behind.
- Remove the left-hand or right-hand side panel (unscrew a further 9 screws).

G. EXCHANGING TUNING CAPACITOR C1

- Note the position of the pulley relative to each extreme of C1.
- Loosen the 4 screws of the flexible coupling and slide it clear.
- Unsolder 2 earth wires on top and the 2 stator leads underneath.
- Remove the 3 large screws and washers; Capacitor C1 is then free. If the first item is accidentally overlooked, the swing of C1 may be restricted.

Note that the extreme positions of the two loops of the driving cord form a symmetrical triangle with the centre of the driving shaft, and should coincide with the extreme positions of C1.

Fault finding

IV

A. GENERAL

For help in the event of faults and for replacing components the assistance of the world-wide PHILIPS Service Organisation can always be called upon.
Some guidance in fault finding can be obtained from a rough check through some of the tests in the chapter "Checking and adjustment".

B. VOLTAGES

First check that the mains voltage is normal and the H.T. voltage is correct. In the case of a breakdown see that the valve heaters and the reference valve B503 are glowing. To facilitate fault finding, the principal voltages and test points are indicated on the circuit diagram and on the drawings of the printed wiring panels.
The voltages are typical only, and can be measured with respect to earth by means of a valve voltmeter, such as PHILIPS type GM 6000, GM 6001 or PM 2400

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C. FAULTS THAT MAY OCCUR

1. Incorrect output voltage

Check that the meter pointer can be set on the calibration line in all ranges (it should not be erratic when the range selector SK1 has shifted slightly, due to dirty contacts). If this is good but the supply voltage is low, check the output stage B3 by checking the depth of amplitude modulation (SK3 set to "INT."). This can be done in one of the lower frequency ranges so that a direct connexion to the Y-amplifier of an RF oscilloscope can be made (for example PHILIPS oscilloscope type PM 3200 or PM 3230). See that the modulation is approximately 30%.

2. Incorrect frequency

Trouble with the diode sweep circuit if the oscillator unit will give errors in some or all ranges, and large errors in the frequency sweeps. Check the sweeps by use of the frequency marker circuit described in chapter V, section H.

3. Absence of frequency sweeps

If the oscillator does not sweep in the ranges 0.4–0.5; 10–11.5 and 88–108 Mc/s, check the modulation voltages in these ranges on the control grid of B1 (pin 9) and also at the cathode (pin 8). Check the current in the diode circuit by measuring the d.c. voltage across R3 (5.6 kΩ) with a multimeter (e.g. PHILIPS type P 817 00, PM 2411).
Check the diodes (apparatus switched off) by determining the passing and blocking resistance by means of a multimeter.

Checking and adjusting

V

A. SURVEY

For the location of the adjustment resistors and the adjusting devices, see Fig. 33...46.

adjustment	*adjustment resistor/ adjusting device*	*unit*	*measuring instrument*	*recommended PHILIPS measuring instrument*	*section*
Supply voltage +175 V	R510	IM 1002	D.C. voltmeter	PM 2411 or P 817 00	B
Calibration of the meter	R35	B	R.F. millivoltmeter	GM 6025 or PM 2451	C
Frequency					
0.15– 0.48 Mc/s	L1, C35	A	Signal generator or wavemeter	–	D
0.48– 1.5 Mc/s	L2, C34			–	
1.5 – 4.8 Mc/s	L3, C33			–	
4.8 – 15 Mc/s	L4, C32				
15 – 50 Mc/s	L5, C31				
10 – 11.5 Mc/s	L6, C39			GM 2621	
88 –108 Mc/s	L7, C38				
0.4 – 0.5 Mc/s	L8, C30				
Output voltage					
0.15– 0.48 Mc/s	R50	A	R.F. millivoltmeter	GM 6025 + GM 6050 T or PM 2401 + PM 9200 + PM 9250	G
0.48– 1.5 Mc/s	R49				
1.5 – 4.8 Mc/s	R48				
4.8 – 15 Mc/s	R47				
15 – 50 Mc/s	R46				
10 – 11.5 Mc/s	R53				
88 –108 Mc/s	R52				
0.4 – 0.5 Mc/s	R51				
Frequency sweep					
0.4 – 0.5 Mc/s	R7	C	see section H		E and H
10 – 11.5 Mc/s	R8				E and H
88 –108 Mc/s	R14				E and H
Modulation depth	R20	C	Radio receiver + R.F. oscilloscope	PM 3200 or PM 3230	F

B. MAINS SUPPLY

Set the supply voltage adapter to the appropriate supply voltage and adjust the voltage across C503 to 175 V by selection of R510. For supply variations of ± 10 % the output should vary by 0.7 V only. The ripple should be 10 mV maximum. When the supply voltage is 220 V, 50 c/s and the voltage adapter is set accordingly, the current taken from the supply should not be more than 180 mA.
Reduce the supply to 198 V and check that the reference valve B503 is ignited (remove the right-hand side panel).

C. ADJUSTMENT OF THE METER

- Set SK1 to position "1.5–4.8 MHz".
- Set the frequency scale to 3 Mc/s.
- Set SK2 to position "OFF"; SK3 to position "EXT". and SK4 to position "EXT.".
- Terminate BU2 with 75 Ω.
- Turn R2 fully clockwise.
- Connect an R.F. voltmeter to BU2 (e.g. GM 6025).
- Adjust the output to 50 mV by means of R1.
- The pointer of the meter should now be set to the calibration line by selection of R35.

D. ADJUSTMENT OF THE FREQUENCY RANGES

1. General

SK2 in position "OFF";
SK3 in position "EXT.";
SK4 in position "EXT."
BU2 terminated with 75 Ω. The meter pointer is always set on the calibration line.

2. The 0.15–0.48 Mc/s range

- Set the frequency scale to 0.15 Mc/s.
- Adjust L1 to give an output frequency of 0.15 Mc/s.
- Set the frequency scale to 0.48 Mc/s.
- Adjust C35 to give an output frequency of 0.48 Mc/s.
- Repeat these adjustments until both are correct.

3. Other ranges

Adjust the other ranges in a similar way using the appropriate coils and capacitors.

4. Checking the scale

After setting the meter-pointer to the calibration line with R1, check every range in at least 3 points. The permitted tolerance is $\pm$ 0.8 %.

E. FM 50 c/s

1. Adjust R3 so that the phase of the modulation voltage differs by 90° from the voltage on BU4 (for section 4: BU5).
Tune by means of an external generator to zero-beat and apply this voltage to the vertical input of an oscilloscope. Connect the horizontal input of the oscilloscope to BU4 or BU5 respectively.

2. Range 0.4-0.5 Mc/s

Tune the generator to 450 kc/s.
- Set SK2 to position "OFF".
- Set SK3 to position "EXT.".
- Set SK4 to position "INT.".
- Adjust the frequency sweep ($2\triangle f$) by means of R7 to 20 kc/s.
- Check at 400 kc/s and 500 kc/s that the sweep lies between 15 and 30 kc/s.
- The asymmetry ($\triangle f_1 - \triangle f_2$) should be $\leq$ 3.5 kc/s.

3. Range 10-11.5 Mc/s

- Tune the generator to 10.7 Mc/s.
- Adjust the frequency sweep ($2\triangle f$) by means of R8 to 400 kc/s.
- Check at 10 Mc/s and 11.5 Mc/s that the sweep lies between 370 and 430 kc/s.
- The asymmetry ($\triangle f_1 - \triangle f_2$) should be $\leq$ 80 kc/s.

4. Range 88-108 Mc/s

- Tune the generator to 100 Mc/s.
- Adjust the frequency sweep ($2\triangle f$) by means of R14 to 150 kc/s.
- Check at 88 Mc/s and 108 Mc/s that the sweep lies between 100 and 200 kc/s.
- The asymmetry ($\triangle f_1 - \triangle f_2$) should be $\leq$ 20 kc/s.

F. AMPLITUDE MODULATION

- SK1 to position "1.5–4.8 MHz".
- Adjust the frequency to 3 Mc/s.
- SK3 to position "EXT.".
- SK4 to position "EXT.".
- Load BU4 with 1 MΩ.
- Adjust R20 to give a modulation depth of 30 %.
- Check that at 0.15 Mc/s and 15 Mc/s the depth of modulation lies between 25 % and 35 %.

G. R.F. VOLTAGE

With a load of 75 Ω on BU2 and R2 fully clockwise, check that it is possible to set the meter pointer to the calibration line with R1 in all the ranges. The limits should be 45–55 mV (with R1 fully clockwise). Adjustment of these output voltages can be made by selection of the resistors R46/R53 mounted on tuning unit A. (See the table, section A.)

H. MEASUREMENT OF THE FREQUENCY SWEEP

A suitable circuit for measuring the extent of the frequency sweeps is shown in Fig. 35. For this two extra generators are required.

1. An R.F. generator capable of generating frequencies of 0.45 Mc/s, 10 Mc/s and 100 Mc/s (e.g. an other PM 5321)
2. **An L.F. generator to cover the range 10 kc/s to 250 kc/s (e.g. PM 5125)**

Connect as in Fig. 32. Adjust PM 5321 (B) to give the desired frequency. Set for maximum output with the meter pointer on the calibration line. Adjust the R.F. generator PM 5321 (A) to the same output voltage and frequency such that a slowly moving lissajous figure is seen on the oscilloscope. Switch SK4 to position "INT."; the f_0 interference marker will be seen on the oscilloscope in the middle of the trace. Check which end of the trace represents $f_0-\Delta f$ or $f_0+\Delta f$, by altering the frequency of PM 5321 (B). Adjust the f_0-marker to be as large as possible and set the L.F. generator to a frequency less than the expected Δf so that two smaller side-band markers become visible. By adjusting the output of PM 5321 (A).

the side-band markers should be made as small as possible. The setting of the L.F. generator at which one of the side-band markers causes the maximum flutter at the end of the trace is equal to Δf. Readjust the L.F. generator to check the other end of the trace (if necessary).

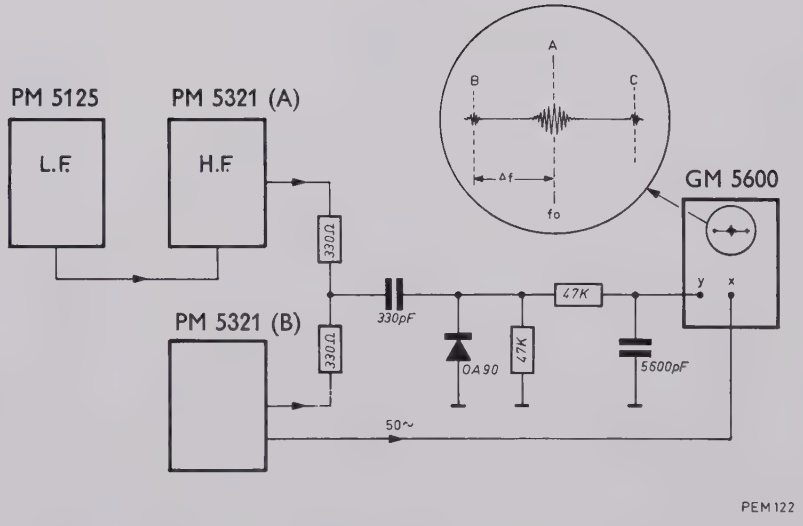

Fig. 32. Circuit for measuring the frequency sweep

List of parts

VI

A. MECHANICAL

Item	*Fig.*	*Quantity*	*Description*	*Code number*
1	33	1	Text plate	4822 455 70049
2	33	1	Scale plate	4822 450 20067
3	33	1	Indicator	4822 450 80117
4	33	1	Grey knob	4822 413 50032
5	33	1	Cap	4822 413 70018
6	33	1	Plastic window	4822 459 40026
7	33	3	Control knob	4822 413 40211
8	33	2	Lid with indication	4822 413 70037
9	33	1	Lid without indication	4822 413 70066
10	33	1	Switching knob	4822 413 40112
11	33	2	Earthing terminal	4822 290 40012
12	33	1	Mains switch	4822 277 10021
13	33	3	Socket	4822 267 30045
14	35	4	Foot	4822 462 40005
15	36	1	Drive cord (50 cm)	4822 321 30101
16	34	1	Thermal fuse	4822 252 20004
17	33	1	H.F. connection socket	4822 267 30045
18	37	1	Mains connection socket	4822 265 20017
19	36	1	Tension spring	4822 492 30033
20	36	1	Reduction gear	4822 535 70058
21	34	1	Contact spring assembly	4822 492 60569
22	33	3	Slide switch	4822 277 20014
23a		1	Stop spring	4822 492 61708
23b		1	Stop roller	4822 528 90204
24	34, 41	1	Complete coil drum A	4822 216 60068
25	36, 42	1	Complete R.F. print plate B	4822 216 60062
26	35, 37, 43, 44	1	Modulator print plate C	4822 216 60063
27	34, 37, 45, 46	1	Print plate, stab. supply unit	4822 216 60067
28	38	1	Grip	4822 498 40002
29	38	2	Mounting bracket	4822 401 10039

B. ELECTRICAL

Resistors

Item	*Ordering number*	*Value*	*Tolerance*	*Power*	*Description*
R1	4822 103 20175	22kΩ	5%	3W	Wire-wound potentiometer
R2	4822 105 40007	75Ω			Preh. potentiometer
R3	4822 103 20094	10kΩ	5%	3W	Wire-wound potentiometer
R5	4822 101 10064	220kΩ	20%	0,25W	Potentiometer
R7, 8, 20	4822 101 10019	1MΩ	20%	0,25W	Potentiometer
R14	4822 101 10022	100kΩ	20%	0,25W	Potentiometer
R505	4822 110 30187	1MΩ	1%	0,25W	Carbon
R507	4822 110 30166	160kΩ	1%	0,5W	Carbon
R508	4822 110 30156	150kΩ	1%	0,5W	Carbon

Capacitors

Item	*Ordering number*	*Value*	*Tolerance*	*V*	*Description*
C1	4822 125 20044				Variable capacitor
C2	4822 121 40013	1 *uF*	10%	250	Polyester
C3	4822 121 40009	0,33 *uF*	10%	250	Polyester
C4	4822 121 40092	0,033 *uF*	10%	250	Polyester
C9	4822 122 10057	560 *pF*	5%	500	Ceramic
C10	4822 122 10051	180 *pF*	5%	500	Ceramic
C11	4822 124 20366	25 *uF*	-10/+50%	25	Electrolytic
C12	4822 120 10063	22 *pF*	5%	500	Ceramic
C13	4822 120 10036	2,2 *pF*	± 0,25 *pF*	500	Ceramic
C14	4822 122 10045	100 *pF*	5%	500	Ceramic
C16	4822 125 50013	25 *pF*		400	Trimmer
C17-C19 C36-C37	**4822 120 10065**	**27 *pF***	**5%**	**500**	**Ceramic**
C18	4822 120 60067	33 *pF*	± 1 *pF*	500	Mica
C24	4822 124 20381	64 *uF*	-10/+50%	64	Electrolytic
C30-C31 C32-C34 C39	4822 125 50015	10 *pF*		400	Trimmer
C33-C35	4822 125 60026	6 *pF*		400	Trimmer
C53	4822 121 40038	0,027 *uF*	10%	250	Polyester
C42-C43-C44 C45-C46 C47-C48 C49-C50 C51-C52	4822 122 70006	1500 *pF*			Feed-through
C54	4822 121 40238	0,033 *uF*	10%	400	Polyester
C55	4822 121 40163	0,039 *uF*	10%	400	Polyester
C58	4822 121 40097	0,27 *uF*	10%	250	Polyester
C59-C60	4822 121 20067	5000 *pF*		250/1600	Jensen
C501/C505	4822 124 40015	16+16 *uF*		500	Electrolytic
C502	4822 121 40011	180 *nF*	10%	400	Polyester
C503	4822 124 20066	8 *uF*	-10/+30%	350	Electrolytic
C504	4822 121 40147	8200 *pF*	10%	400	Polyester

Miscellaneous

Item	*Quantity*	*Description*	*Code number*
T1	1	Supply transformer	4822 146 40028
L1	1	Oscillator coil	4822 156 30054
L2	1	Oscillator coil	4822 156 30053
L3	1	Oscillator coil	4822 156 30052
L4	1	Oscillator coil	4822 156 30051
L5	1	Oscillator coil	4822 156 30055
L6	1	Oscillator coil	4822 156 30056
L7	1	Oscillator coil	4822 156 30154
L8	1	Oscillator coil	4822 156 40137
L10, 11	2	Choke core	4822 526 10002
L12	1	Choke	4822 157 30055
L13, 14	2	Choke core	4822 526 10019
ME1	1	Meter	4822 346 10061

Valves, diodes and transistors

B1	ECF80	Triode pentode
B2	ECC85	Double triode
B3	E80F	Pentode
B501	EZ80	Rectifier
B502	PCL82	Triode pentode
B503	85A2	Stabiliser
GR1	OA79	Germanium diode
GR2	OA73	Germanium diode
TR1	BC107	Transistor

Impedance transformer (PM 9532B)

Item	*Fig.*	*Quantity*	*Description*	*Code number*
1	40	2	Plug	4822 264 30018
2	40	1	300 Ω cable (100 mm)	4822 320 10019
3	40	1	Box	4822 532 30025
5	40	1	75 Ω cable (1.3 m)	4822 320 10028
6	40	1	BNC connector	4822 265 10003
7	40	1	Transformer	4822 158 10002

Resistors of the impedance transformer

Item	*Code number*	*Value*	*Tolerance*	*Power*	*Description*
R1	4822 116 50854	86 Ω	1 %	0.2 W	Carbon resistor
R2	4822 116 50167	150 Ω	2 %	0.2 W	Carbon resistor
R3	4822 116 50087	110 Ω	2 %	0.2 W	Carbon resistor

Artificial aerial (4822 210 70023)

Fig.	*Quantity*	*Description*	*Code number*
29	1	Complete aerial	4822 210 70023
29	1	Measuring pin	4822 264 20008

Electrical parts of the artificial aerial

Item	*Code number*	*Value*	*Tolerance*	*Volts*	*Descriptioa*
L100 R100	4822 157 30056				
C100	4822 122 10052	220 pF	10 %	500	Ceramic capacitor
C101	4822 122 10052	220 pF	10 %	500	Ceramic capacitor
C102	4822 817 11018	1.5 nF	10 %	500	Ceramic capacitor
C103	4822 817 11005 4822 817 11005 } Parallel	30 nF	10 %	350	Ceramic capacitor

Measuring cable

Item	*Fig.*	*Quantity*	*Description*	*Code number*
–	39	1	Complete cable	4822 321 20094
1	39	1	75 Ω cable (1 m)	4822 320 10028
2	39	1	BNC plug	4822 265 10003
3	39	1	Coaxial plug	4822 264 10021
4	39	1	Banana plug	4822 264 30033

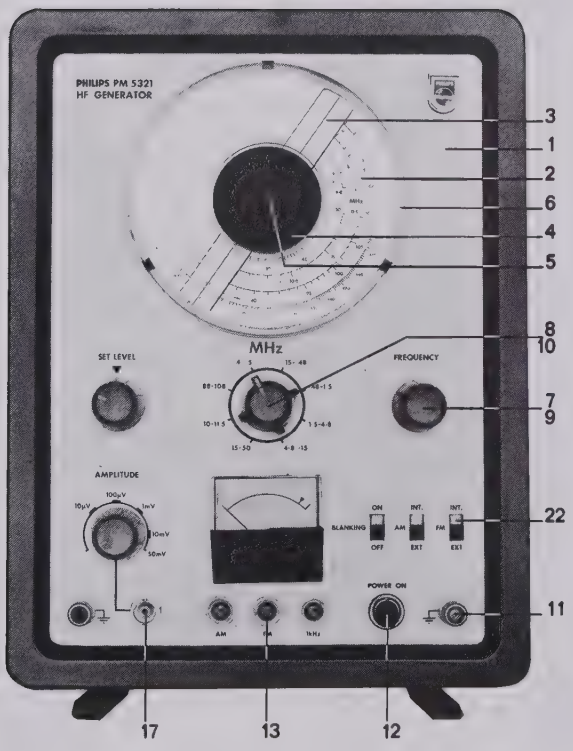

Fig. 33. Front view; indication of parts

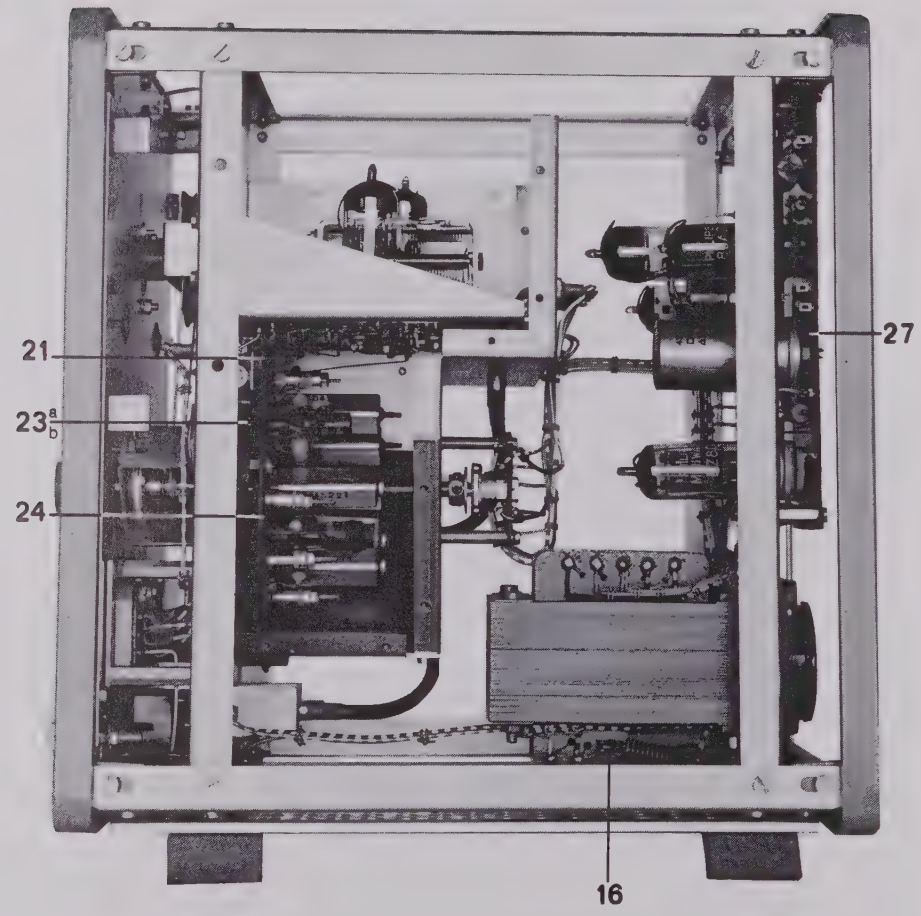

Fig. 34. Right-hand side-view; indication of parts

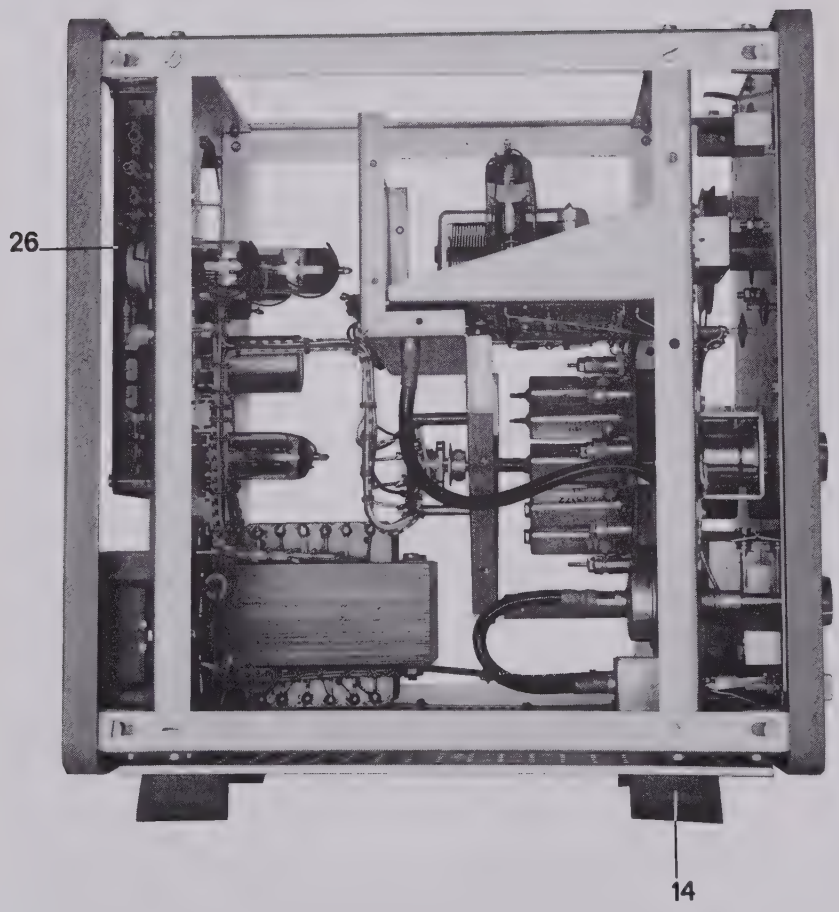

Fig. 35. Left-hand side-view; indication of parts

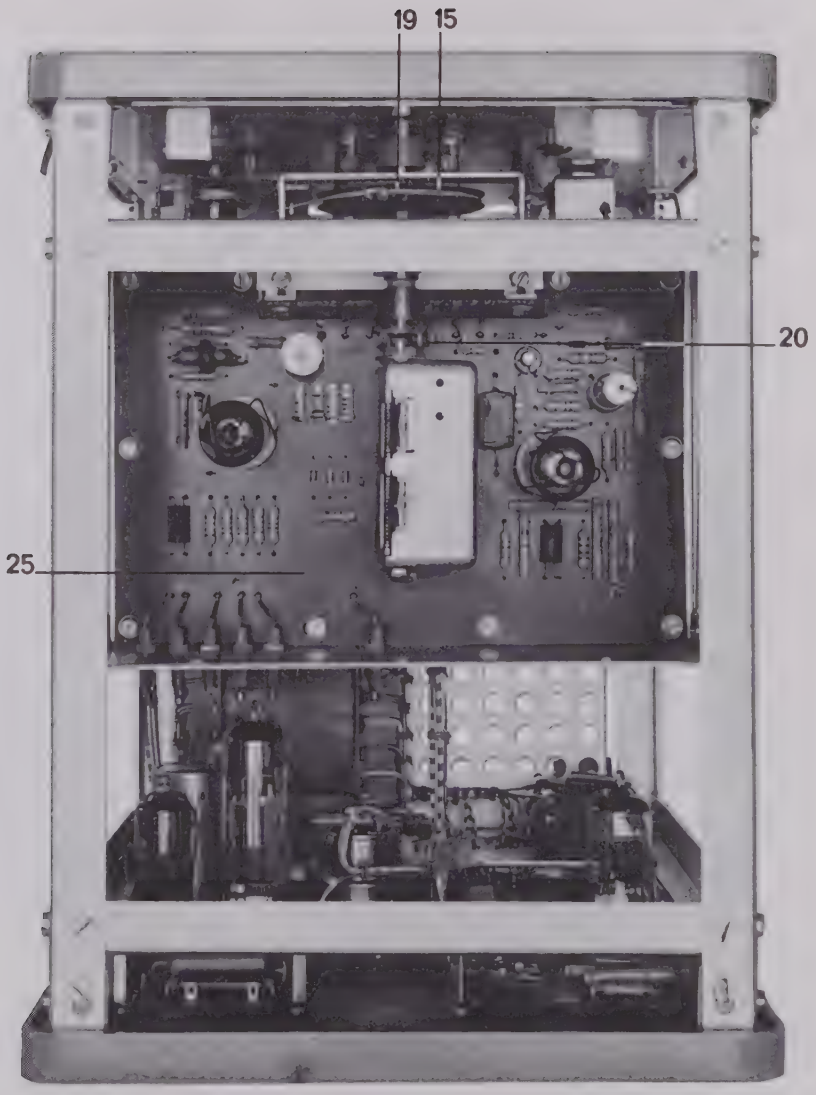

Fig. 36. Top view; indication of parts

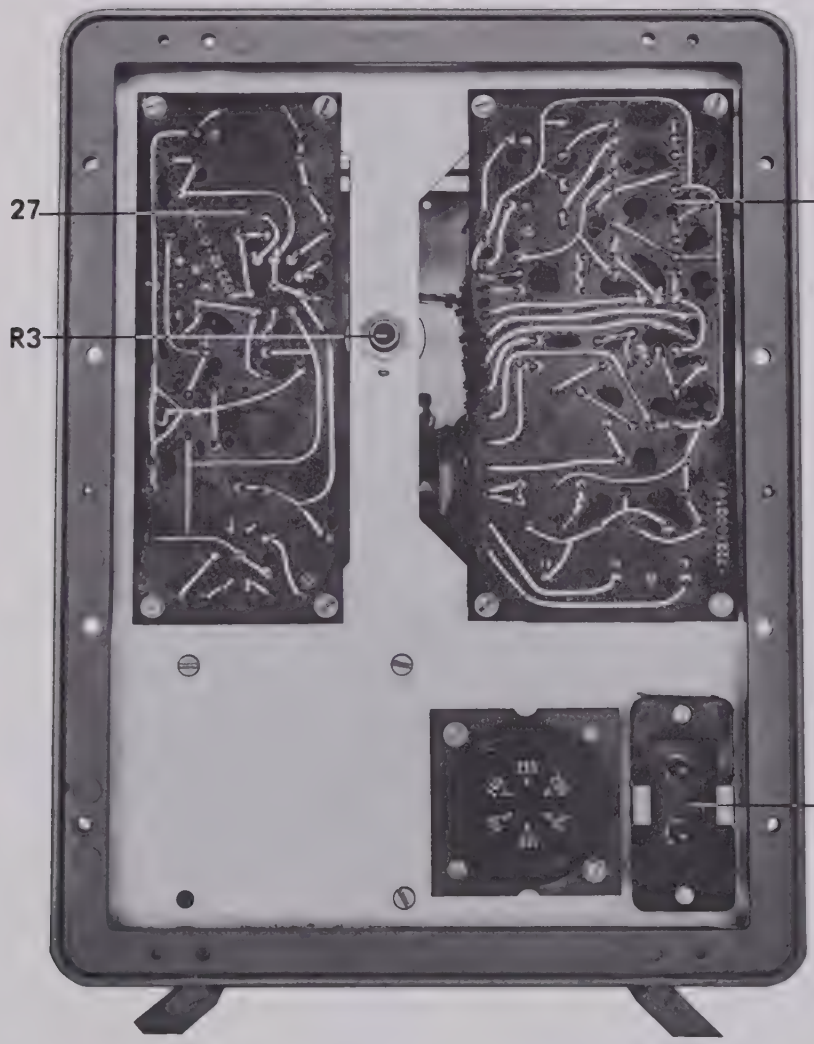

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Fig. 37. Rear view; indication of parts

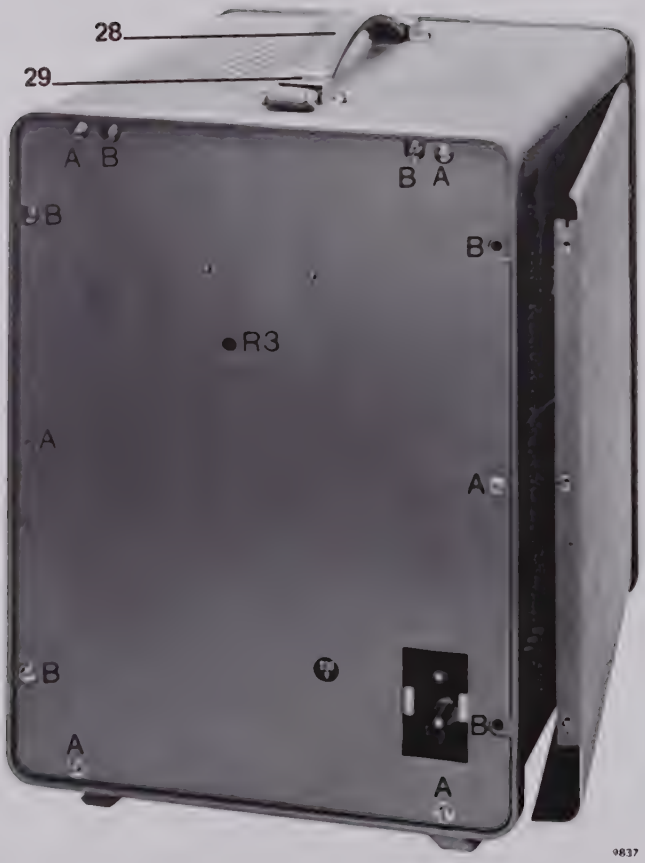

Fig. 38. Rear view; indication of parts

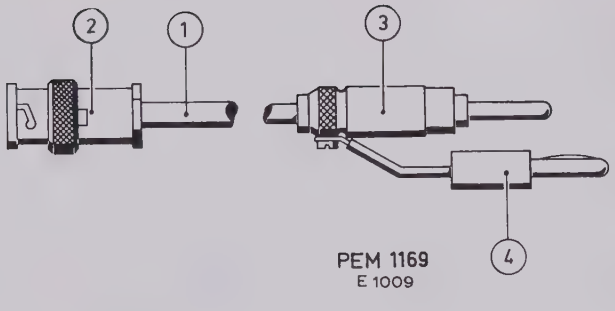

Fig. 39. Measuring cable

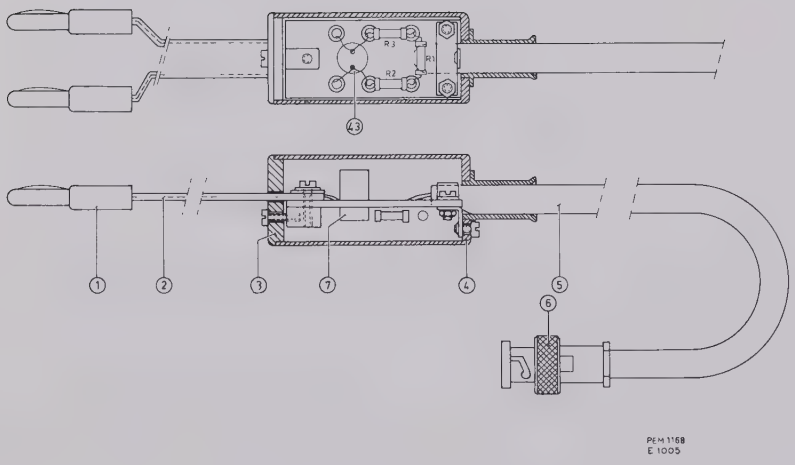

Fig. 40. Impedance transformer

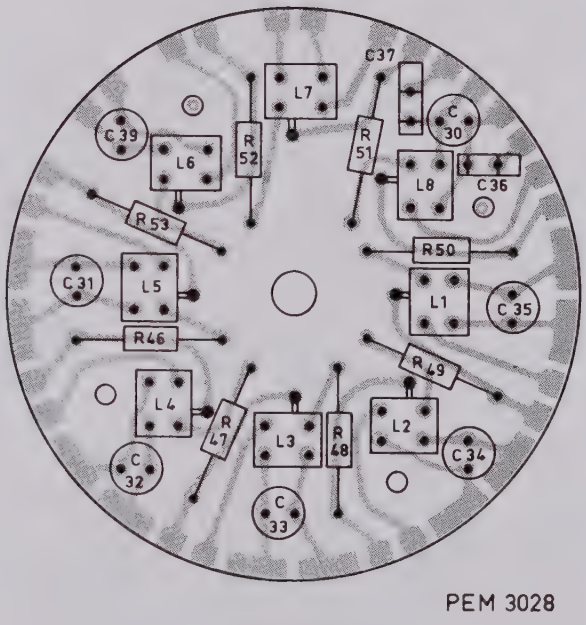

Fig. 41. Print A; tuning unit

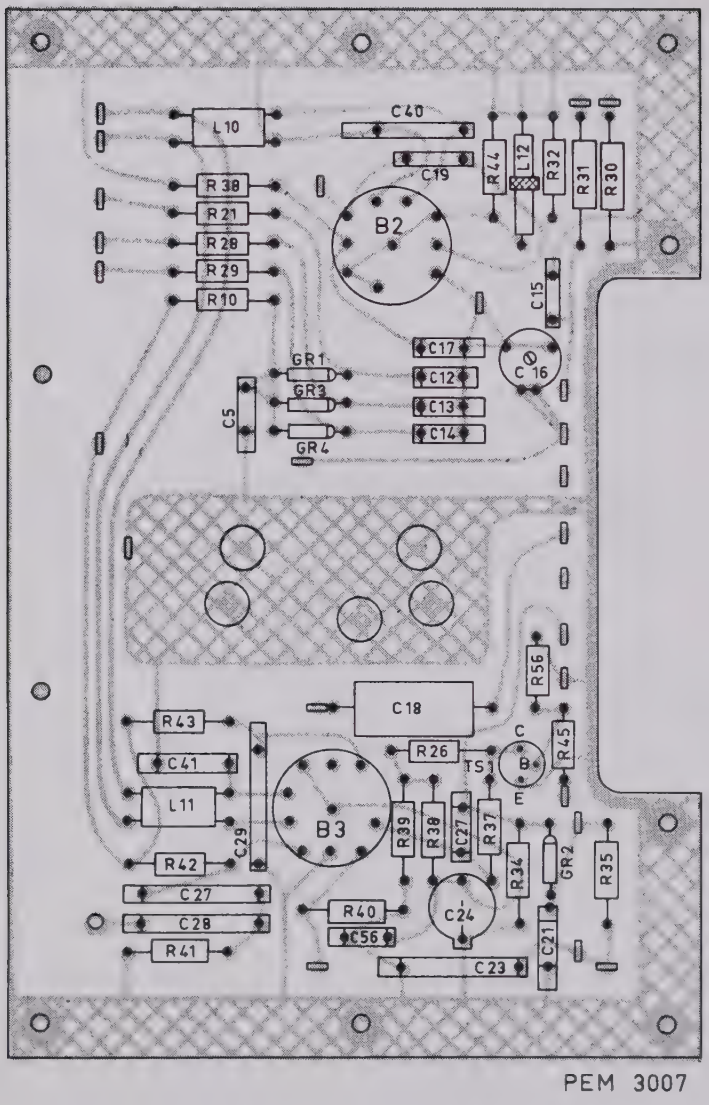

Fig. 42. Print B; R.F. unit

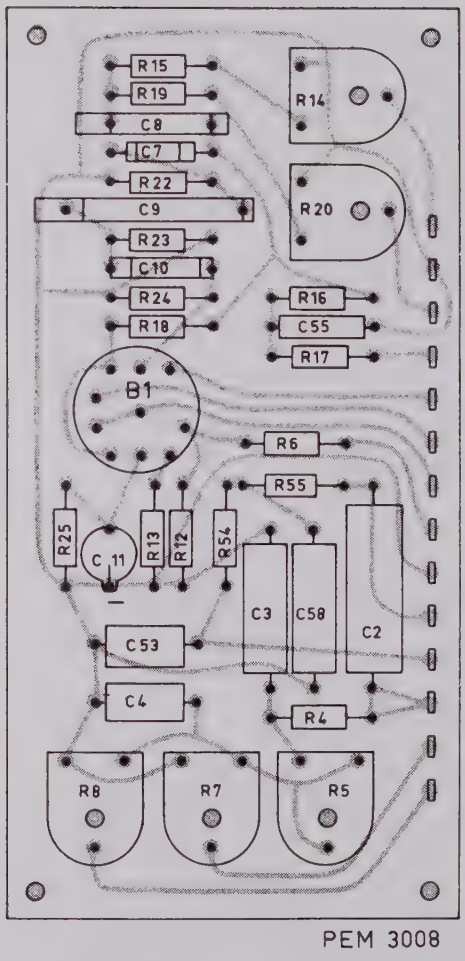

Fig. 43. Print C; modulator unit, side of parts

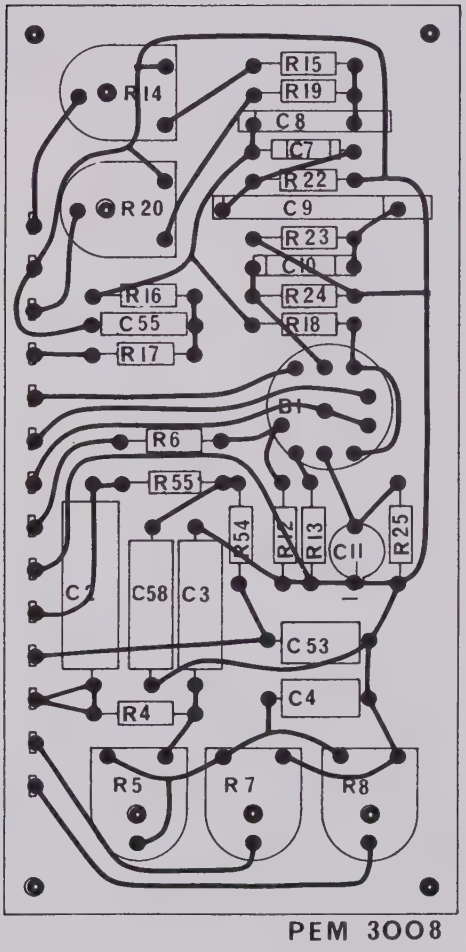

Fig. 44 Print C; modulator unit, side of tracks

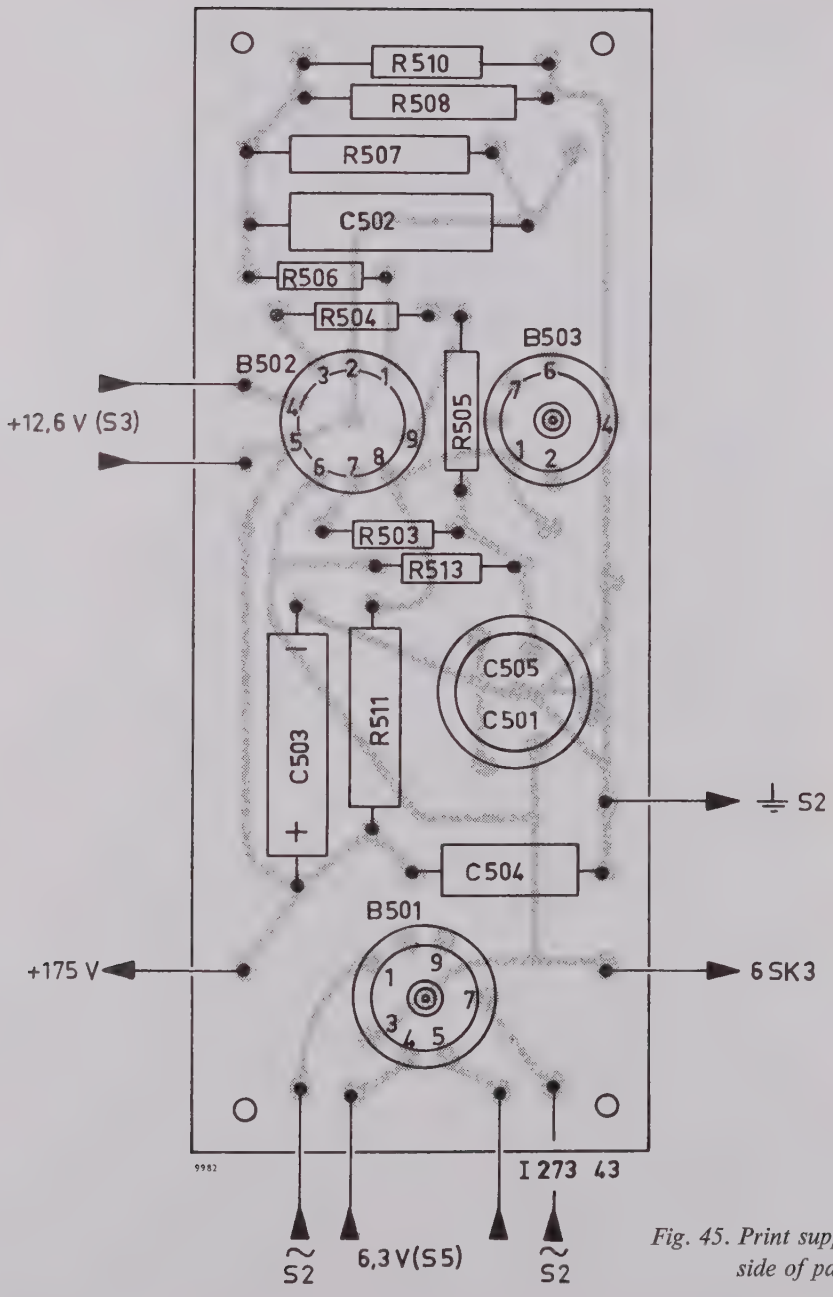

Fig. 45. Print supply part, side of parts

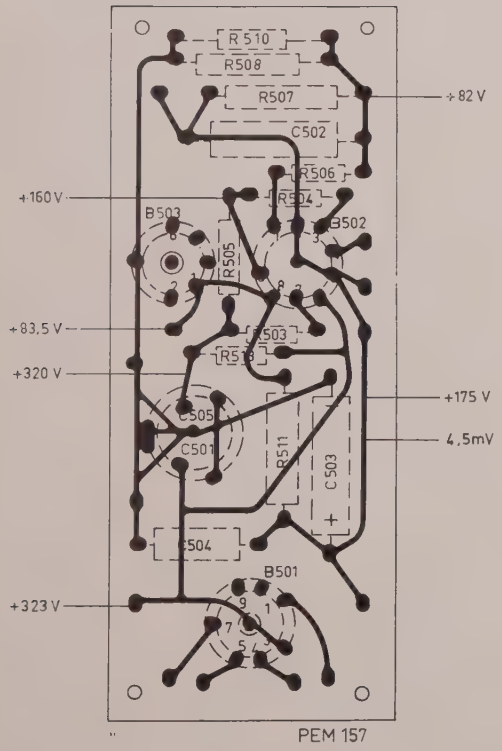

Fig. 46. Print supply part, side of tracks

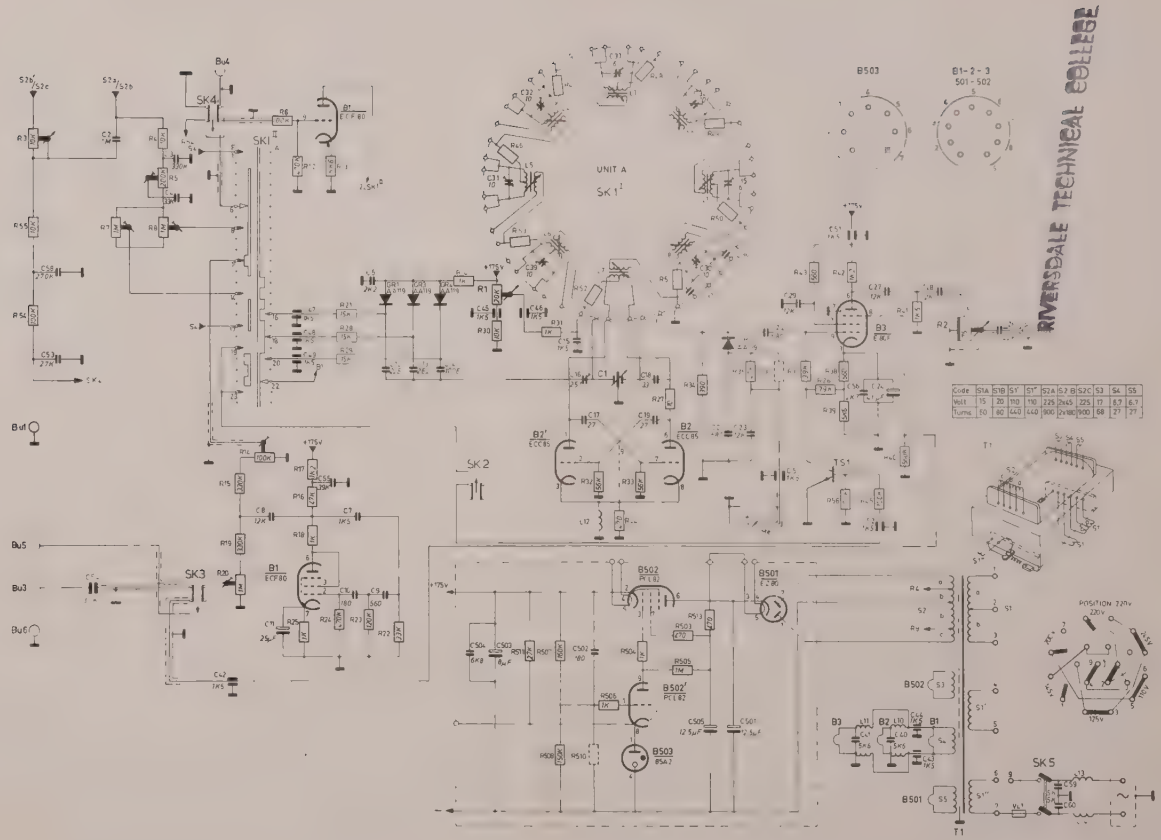

Fig. 47. Circuit diagram

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